SPECIAL REPORT

OF THE

Vermont Water Resource Commission

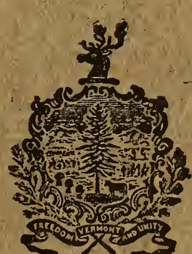
TO THE LEGISLATURE OF 1921

OF THE

STATE OF VERMONT

MADE IN ACCORDANCE WITH No. 328
OF THE ACTS OF 1919

Prepared in Co-operation with the United States Geological Survey
C. H. PIERCE, District Engineer



FEBRUARY, 1921

THE TUTTLE COMPANY, Publishers
MARBLE CITY PRESS
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To the Governor and General Assembly of the State of Vermont:

In accordance with the provisions of a joint resolution passed at the biennial session of 1919, being No. 328 of the acts of that session, we have the honor to make the following report.

WALTER A. DUTTON
WM. R. WARNER
ELI. H. PORTER
Public Service Commission of Vermont

H. M. McINTOSH
State Engineer

Report of the Water Resource Commission

The joint resolution hereinbefore referred to provided that the public service commission and the state engineer should constitute a commission to investigate the water resources of the state now developed or capable of development and to suggest methods of conserving, developing, and utilizing the same. The commission was given authority to study the methods and policies of the various persons and corporations in control of the water resources of the state with a view to increasing the service and benefits to be secured from them; and was required to report to the next session of the General Assembly and to include in their report such recommendations and drafts of legislation as to them might seem expedient.

No appropriation was made by the legislature for the payment of any expense incident to the performance of the duties provided by the resolution.

The amount of work laid out in the said resolution might easily call for the services of a large corps of engineers and accountants during the entire biennial period; but in view of the fact that no provision was made for the payment of any such expenses the commission did not feel warranted in incurring them; the result being that the commission has limited its efforts to the securing of such information only as could be obtained without extra expense to the state.

THE CONSERVATION COMMISSION OF 1915

By No. 240 of the acts of 1915 provision was made for the appointment by the governor of three persons to constitute a conservation commission to serve for two years without pay.

The act provided for the payment of the actual expenses of the commission, for clerical and stenographic assistance not to exceed five hundred dollars annually, and authorized the employment of expert engineering advice and service and to expend for that purpose not to exceed twenty-five hundred dollars for the biennial period.

The commission was given general authority to investigate and determine desirable locations for storage reservoirs to store and hold flood water with a view to the prevention of damage by flood and the benefit of water powers developed and undeveloped, all of which appears by the act referred to, and were required to report to the next session of the General Assembly.

Pursuant to the provisions of this act Governor Charles W. Gates appointed as members of said commission former Lieutenant Governor Charles H. Stearns of Johnson, the present State Engineer H. M. McIntosh of Burlington, and Mr. James A. Stacy of White River Junction.

The commission so appointed performed its duties and made report to the General Assembly at the session of 1917.

This report, published in a pamphlet of twenty-eight pages, contains much valuable general information and some particular information concerning the streams, lakes and ponds of Vermont, with numerous maps and drawings.

CO-OPERATION WITH UNITED STATES GEOLOGICAL SURVEY

By No. 289 of the Acts of 1912 the General Assembly appropriated twelve hundred dollars annually for "determining the amount of water available on streams of this state, for investigating the best methods of utilizing the same, and for providing the people of this state with such information relating thereto as will further industrial development."

By section 2 of that act the governor was authorized to enter into a co-operative agreement with the director of the United States geological survey for the purpose of making the investigation aforesaid. Section 3 of the act provided in what manner the money should be expended in case such co-operative agreement was entered into and how it should be expended in case no such co-operative agreement was made. Section 4 of the act provided for an annual report to the governor by the director of the United States geological survey.

By No. 139 of the Acts of 1917 the Act of 1912 was amended so as to cast upon the state engineer instead of the governor the duty of co-operating with the director of the United States geological survey.

The acts referred to are now found in General Laws, section 403; and since the said Act of 1912 became a law the sum of twelve hundred dollars has been made annually available for the purposes set forth therein.

Pursuant to the provisions of that act and the amendments thereto the state engineer entered into a co-operative agreement with the director of the United States geological survey; and, under that agreement, investigations of the streams, lakes and ponds, water sheds, reservoirs, opportunities for storage, water powers developed and undeveloped and other related subject matters, have been carried on and the results of those investigations appear in reports which have been made from time to time

and published at the government printing office at Washington. One of those reports is dated in 1917 and is entitled "Water-Supply, Paper 424."

That report contains under the title of "Gazetteer of Streams" a general description of nearly or quite all the streams and bodies of water in the state arranged by names in alphabetical order and covers seventy-seven pages of that report. It may be obtained from the superintendent of documents at the government printing office at Washington, D. C., for twenty-five cents.

Prior to the co-operative arrangement between the state of Vermont and the director of United States geological survey, gauging stations had been established under the authority of the last named government officer upon several of the principal streams in Vermont for the purpose of measuring the quantity of water flowing in those streams; and, since the establishment of co-operation between the general government in this state, that practice has continued until the present time and has resulted in the accumulation of much valuable information as to the flow of water in the different streams at the various seasons of the year.

Government investigations, the results of which appear in Water-Supply Paper 424 hereinbefore referred to, were in charge of C. H. Pierce, District Engineer, with headquarters at Boston.

During the last biennial period this work has been continued under the joint arrangement, Mr. Pierce co-operating with State Engineer McIntosh, and the report of their work is hereinafter contained and made a part of this report.

The work undertaken by the general government and the State of Vermont in co-operation during the last biennial period has covered not only the measuring of the water in the streams in Vermont but has taken up the examination of the general features including the amount of water power at present installed, the opportunities for further development of water powers and for storage basins, and certain other geological features relating to the White River basin, all of which information will be of great value to persons who may hereafter engage in the improvement of the water powers in that basin.

Vermont is rich in small water powers on a large number of its rivers and at the outlet of its numerous ponds and lakes; but the problem of the future would seem to be to provide some plan by which the enormous quantity of water running to waste during high water periods may be impounded and made available for the production of power during times of drouth.

The great advance in price of coal as fuel has made the use of power in this vicinity produced by that means prohibitive; and the increasing demand for power must be supplied from some other source. That source lies in the creation of storage reservoirs which will serve the double purpose, of preventing damage by floods and storing water for use in the production of power.

The advantage obtained by providing for an even, constant flow of water in the power-producing streams is well illustrated by the facts which appear upon pages 9 and 10 of the report of the conservation commission hereinbefore referred to as to the results in the Deerfield valley. There a storage reservoir has been completed with a capacity of 2,600,000,000 cubic feet, sufficient to hold back the entire rain fall of the Deerfield river valley above that point. The water thus kept in storage is released when needed and assures a constant flow in the stream below, relieving power producers of the necessity of building and maintaining expensive auxiliary steam plants, which would otherwise be necessary to bridge over times of low water.

Electric power is now being applied to a great variety of uses and enters more and more into the daily activities of all lines of endeavor. It is well worth considering by the legislature what can be done to increase the efficiency and cheapen the cost of this powerful agency.

For these reasons we recommend that the joint arrangement which has existed be continued and that during the next biennial period information similar to that which is presented in this report as to the White River basin be procured respecting the basins of other streams in the state, carrying this investigation as far as possible within the limits of the appropriation for that purpose.

As this work comes naturally within the province of the engineering department we recommend that it be left as at present within the jurisdiction of the state engineer.

PROGRESS OF STREAM GAGING IN VERMONT

During the two-year period ending Sept. 30, 1920.

Boston, November, 15, 1920.

To the Honorable, The Governor of Vermont,
State House, Montpelier, Vt.

Dear Sir:

The work of investigating the water resources of Vermont has been carried on during the past two years in co-operation with the State, the co-operating state official being Mr. H. M. McIntosh, State Engineer. In addition to obtaining records of stream flow, an effort has been made to obtain data relative to use of the water, and this information has been secured for a considerable number of the water power developments.

A knowledge of the exact location, size, and use of the power developments, together with information respecting additional possibilities for developing power or increasing the power by means of storage, should be of value to the general public and also to state boards and commissions having to do with problems in valuation and rate making.

It has not been considered practicable to include in this report all of the water power data that have been obtained, but the information has been compiled for the White River basin, and is transmitted herewith, together with the tables showing the flow of the rivers as measured at the gaging stations.

The tables accompanying this report show the daily and monthly discharge at eleven gaging stations. The stations on Otter Creek at Middlebury, Dog River at Northfield, and Passumpsic River near St. Johnsbury have now been discontinued, and new stations established on West River at Newfane, Mollys Brook near Marshfield, Jail Branch of Winooski River at East Barre, and Second Branch of White River near North Randolph. All of the gaging stations now being maintained are well equipped and good records are being obtained.

Respectfully submitted,

C. H. PIERCE,
District Engineer.

UNITED STATES GEOLOGICAL SURVEY
IN CO-OPERATION WITH THE STATE OF VERMONT

Records of Stream Flow for the Two-Year Period ending September 30, 1920

Lake Champlain drainage basin:

- Lake Champlain (gage heights)
- Otter Creek
- Winooski River
  - Dog River
- Lamoille River
  - Green River
- Missisquoi River

Lake Memphremagog drainage basin:

- Clyde River

Connecticut River drainage basin:

- Connecticut River
  - Passumpsic River
  - White River
  - West River

LAKE CHAMPLAIN AT BURLINGTON, VT.

Location.—On south side of roadway leading to dock of Champlain Transportation Co., at foot of King St., Burlington.

Records available.—May 1, 1907, to September 30, 1920.

Gage.—Staff. Comparisons of gage readings indicate that zero of gage at Burlington is at practically the same elevation as that of gage at Fort Montgomery, 92.5 feet above mean sea level. Gage read by employee of the Champlain Transportation Co.

Extremes of stage.—1907-1920: Maximum stage recorded, 8.20 feet on April 7, 1913; minimum stage recorded,—0.25 foot on December 4, 1908.

Ice.—Lake Champlain does not usually close over in its wider portions until the latter part of January. Occasionally the period of closure does not occur until February, and sometimes only lasts for a few days. At the northern end of the lake above the outlet the period of ice cover is usually from the middle of December to the middle of April.

Accuracy.—Gage read to hundredths once a day at irregular intervals. When the lake is rough, there is considerable wave action at the gage and readings at those times may not be exact.

Co-operation.—Gage heights furnished through the courtesy of Mr. D. A. Lomis, general manager of the Champlain Transportation Co.

Daily gage height, in feet, of Lake Champlain at Burlington, Vt., for the years ending Sept. 30, 1919 and 1920.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	2.75	4.75	....	....	3.47	2.56	4.82	....	....	3.10	....	1.18
2	....	4.95	....	4.20	....	....	4.80	5.80	4.85	3.05	1.70	1.18
3	2.74	....	4.75	4.30	3.43	2.68	4.77	5.76	4.79	2.96	....	....
4	....	4.95	4.70	....	....	2.76	4.78	....	4.74	2.92	1.68	1.16
5	3.00	5.00	....	....	3.30	2.82	4.80	5.68	4.60	2.88	1.64	....
6	....	4.97	4.62	....	....	2.88	....	5.82	....	....	....	....
7	3.65	....	....	....	3.22	2.96	4.90	....	....	2.78	1.58	....
8	4.06	4.80	....	4.12	....	2.98	5.22	5.70	....	2.72	....	1.06
9	4.15	....	4.35	....	....	....	5.47	5.74	....	....	1.56	....
10	4.24	....	4.30	....	3.10	3.02	....	5.67	4.33	....	....	....
11	4.22	4.72	....	....	....	3.12	5.50	....	4.22	2.59	1.46	....
12	....	4.60	....	....	3.00	3.14	5.93	5.57	4.16	2.46	1.44	....
13	....	....	4.13	....	2.97	....	....	5.45	4.06	....	....	1.40
14	....	4.42	....	3.88	....	....	6.50	5.38	3.97	2.38	1.38	....
15	....	....	....	....	....	3.24	6.58	5.25	....	2.33	1.36	1.52
16	4.10	4.22	4.33	....	....	....	6.60	....	3.96	....	1.36	....
17	4.02	....	4.43	3.75	2.86	3.14	6.65	....	3.90	2.32	....	....
18	....	4.30	4.38	3.72	2.82	3.20	6.67	....	3.88	2.28	1.34	....
19	....	4.67	....	....	....	3.37	6.70	5.07	....	2.26	....	....
20	....	5.03	....	....	2.74	3.46	....	5.07	3.80	....	1.24	1.40
21	....	5.23	....	3.60	2.70	3.70	6.60	5.02	....	2.18	1.24	....
22	3.93	5.28	....	....	....	3.87	6.58	4.95	....	....	....	1.40
23	3.95	....	4.13	....	....	....	....	....	....	2.10	1.24	1.40
24	....	....	....	3.55	2.60	4.07	6.36	5.30	3.50	....	....	....
25	....	....	....	....	2.56	4.10	....	....	....	....	1.22	....
26	3.90	5.15	....	....	2.56	4.10	6.22	5.33	3.35	....	1.24	1.40
27	....	....	....	....	....	4.10	6.12	5.31	3.27	....	....	....
28	....	....	4.37	....	2.48	4.28	6.06	5.26	....	....	....	....
29	3.90	4.90	....	....	....	4.60	6.02	5.19	....	....	1.18	....
30	4.10	....	4.33	3.50	....	....	5.96	....	3.16	1.88	....	1.30
31	4.40	....	4.30	....	....	4.78	....	5.06	....	1.80	....	....
1919-20												
1	1.32	2.46	3.22	....	....	....	6.30	7.72	4.75	2.78	....	....
2	....	....	3.30	....	....	1.64	....	....	4.70	2.75	....	....
3	1.38	2.77	3.26	....	....	....	6.45	7.60	4.60	....	2.24	1.56
4	1.46	2.82	....	....	1.80	....	....	7.60	4.50	....	....	....
5	....	2.90	....	2.35	....	1.62	6.55	7.50	4.40	....	2.16	1.45
6	1.56	3.10	3.15	....	....	....	6.80	7.40	....	2.68	....	....
7	1.72	3.15	....	....	....	....	6.94	7.28	4.27	2.60	2.06	1.42
8	1.83	3.20	3.12	....	....	....	6.98	7.12	4.15	....	....	....
9	1.86	....	3.08	....	1.78	1.72	6.90	....	4.08	2.62	2.02	1.46
10	....	3.25	....	....	....	1.74	....	6.98	4.05	2.68	....	....
11	1.92	....	3.20	....	....	1.78	....	6.88	3.90	....	....	1.44
12	....	....	....	2.10	....	1.74	....	6.78	3.85	2.64	1.97	....
13	2.02	....	....	....	....	1.90	6.70	6.66	....	2.60	....	....
14	....	....	....	....	....	....	6.90	6.57	3.68	....	....	1.56
15	2.04	3.45	....	....	....	2.30	7.14	6.45	3.63	2.52	....	1.65
16	2.07	....	3.16	....	1.74	2.40	7.20	....	3.63	2.52	1.94	....
17	2.06	....	....	....	....	2.50	....	6.20	3.53	....	1.94	1.60
18	2.08	3.38	....	....	....	2.84	....	6.15	3.45	....	....	1.58
19	....	....	....	1.98	....	3.06	7.25	5.97	3.40	2.52	1.90	....
20	2.12	....	2.96	....	....	3.22	7.20	5.86	3.34	....	....	1.60
21	....	....	....	....	....	....	....	5.77	3.30	2.49	....	....
22	....	....	....	....	....	3.40	7.22	5.68	....	2.49	1.72	....
23	2.19	....	2.86	1.95	....	3.50	7.30	....	3.14	2.50	1.76	1.54
24	2.20	3.30	....	....	....	3.65	7.42	5.53	3.10	....	....	....
25	....	3.28	....	....	....	4.00	....	5.47	3.04	....	1.70	....
26	....	3.28	....	1.94	....	4.42	7.60	5.42	2.98	....	....	....
27	2.13	....	2.65	....	....	4.82	7.55	5.32	....	2.48	....	1.52
28	....	3.28	....	....	....	....	7.55	5.22	....	2.36	....	....
29	2.16	....	2.65	....	....	5.85	....	5.12	2.82	2.32	1.65	1.50
30	....	....	....	....	....	5.98	7.70	....	2.80	2.25	1.65	1.48
31	....	....	2.60	....	....	6.20	....	....	....	2.26	....	....

Otter Creek at Middlebury, Vt.

Location.—At the railroad bridge about half a mile south of the railroad station at Middlebury, Addison County, 3½ miles below the mouth of Middlebury River, and 3½ miles above mouth of New Haven River.

Drainage area.—615 square miles.

Records available.—April 1, 1903, to May 1, 1907, and October 5, 1910, to January 31, 1920.

Gage.—Chain; read by N. A. Brooks.

Discharge measurements.—Made from a boat just below railroad bridge, at the stone-arch highway bridge just above the dam, or by wading.

Channel and control.—Channel deep; current sluggish for several miles above the station. Control for low stages is gravel and boulder rips about 800 feet below gage, and is somewhat shifting; control at high stages is near the dam 800 feet farther downstream.

Extremes of discharge.—1903-1907 and 1910-1920: Maximum stage recorded 21.07 feet March 30, 1913 (approximate discharge from extension of rating curve, about 8,000 second-feet); minimum open-water stage recorded, 11.45 feet September 15, 1913 (discharge 138 second-feet). A somewhat lower discharge has possibly occurred at various times when the stage-discharge relation was affected by ice.

Ice.—Ice usually forms to a considerable thickness at the gage and occasionally at the control, affecting the stage-discharge relation during most winters.

Regulation.—Probably little if any effect from power developments above the station. Considerable storage has been developed on tributaries near the headwaters.

Accuracy.—Stage-discharge relation has changed slightly at various times. Rating curves fairly well defined for periods used. Chain gage read to quarter-tenths once daily. Daily discharge ascertained by applying rating table to daily gage heights. Results fair.

Discharge measurements of Otter Creek at Middlebury, Vt., during the two-year period ending September 30, 1920.

Date	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
Jan. 3	R. H. Suttie	14.11	1,660
4	R. H. Suttie	14.17	1,720
Feb. 27	M. R. Stackpole	12.38	531
28	M. R. Stackpole	12.44	553
28	M. R. Stackpole	12.42	541
June 26	R. H. Suttie	12.15	355
27	R. H. Suttie	12.22	377
27	R. H. Suttie	12.22	390
29	R. H. Suttie	12.84	737
29	R. H. Suttie	12.80	700
Sept. 15	M. R. Stackpole	14.55	2,010
1920			
Jan. 20	H. S. Price	(a) 12.50	283

(a) Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Otter Creek at Middlebury, Vt., for the years ending Sept. 30, 1919 and 1920.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	1,440	2,420	870	1,280	930	2,420	2,150	970	585	475	352	375
2	970	2,150	780	1,440	840	2,240	2,150	900	530	425	375	400
3	765	1,610	690	1,700	720	2,240	2,150	1,110	475	375	352	425
4	830	1,360	750	1,700	720	2,330	1,880	1,110	425	352	290	475
5	735	1,130	780	1,790	720	2,420	1,790	1,040	375	290	270	475
6	1,270	1,060	660	1,790	690	2,060	1,970	1,190	375	224	330	530
7	1,970	930	780	1,610	660	1,970	2,330	1,110	425	250	400	475
8	1,700	870	635	1,200	660	1,440	2,420	1,040	425	375	375	352
9	1,350	840	660	1,130	560	1,360	2,330	1,040	425	375	425	675
10	1,040	780	750	1,280	510	1,790	2,420	900	475	330	425	1,110
11	900	690	635	1,280	535	1,970	2,330	765	500	352	330	970
12	765	690	635	1,700	585	1,790	3,050	765	530	425	290	352
13	705	690	635	1,130	535	1,520	2,870	830	400	425	330	2,510
14	585	660	660	810	510	1,190	2,780	830	375	330	352	2,330
15	705	635	1,610	810	485	900	2,870	735	350	375	352	2,150
16	615	635	1,700	870	485	830	2,780	645	270	375	375	1,970
17	615	635	1,610	810	440	830	2,690	675	425	330	330	1,610
18	500	585	930	810	485	1,040	2,690	1,270	530	330	290	1,110
19	615	2,510	1,610	810	510	1,700	2,510	1,520	615	330	330	830
20	585	2,510	870	810	485	1,700	2,420	1,440	585	310	425	645
21	530	2,420	870	720	485	1,790	2,240	1,360	475	270	425	585
22	645	2,150	810	720	485	1,880	2,150	970	425	290	475	550
23	735	1,880	1,200	690	440	1,790	1,880	2,060	270	425	475	550
24	675	1,440	1,610	1,280	415	1,610	1,520	2,150	400	530	425	645
25	615	1,200	1,530	1,790	485	1,360	1,270	2,150	400	475	425	735
26	555	930	1,970	1,610	535	1,190	1,190	2,150	375	450	400	735
27	615	780	1,880	1,530	585	1,190	1,040	1,970	350	450	450	705
28	705	750	1,700	1,280	585	1,970	970	1,700	765	352	530	615
29	705	720	1,610	1,130	.....	2,150	970	1,270	735	375	500	500
30	675	990	1,130	1,060	.....	2,330	1,040	970	585	425	475	500
31	2,690	.....	1,280	930	.....	2,150	.....	765	.....	375	475	.....
1919-20												
1	475	1,440	2,060	370								
2	450	1,610	2,150	330								
3	502	1,610	2,150	330								
4	530	1,610	1,790	250								
5	530	1,440	1,440	220								
6	475	1,790	1,520	220								
7	830	1,970	1,040	250								
8	900	1,790	1,040	250								
9	735	1,610	1,040	290								
10	645	1,440	970	290								
11	645	1,270	2,150	290								
12	705	1,350	1,790	220								
13	645	2,240	1,270	250								
14	585	2,330	1,520	250								
15	557	2,240	1,610	290								
16	530	2,150	900	290								
17	830	1,880	840	250								
18	1,440	1,610	820	330								
19	1,270	1,350	760	250								
20	970	1,110	700	290								
21	900	970	640	290								
22	900	900	580	290								
23	970	1,190	580	250								
24	900	1,270	560	290								
25	765	1,190	540	290								
26	645	1,040	420	220								
27	705	1,040	420	290								
28	1,040	1,040	400	290								
29	1,270	1,110	400	250								
30	1,190	1,610	380	250								
31	1,110	.....	380	250								

Monthly discharge of Otter Creek at Middlebury, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 615 square miles.)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	2,690	500	897	1.46	1.68
November	2,510	585	1,220	1.98	2.21
December	1,970	635	1,090	1.77	2.04
January	1,790	690	1,210	1.97	2.27
February	930	415	574	.933	.97
March	2,420	830	1,710	2.78	3.20
April	3,050	970	2,100	3.41	3.81
May	2,150	645	1,210	1.97	2.27
June	765	270	462	.751	.84
July	530	224	370	.602	.69
August	530	290	389	.633	.73
September	2,510	352	863	1.40	1.56
The year	3,050	224	1,010	1.64	22.27
1919-20					
October	1,440	450	795	1.29	1.49
November	2,330	900	1,510	2.46	2.74
December	2,150	380	1,060	1.72	1.98
January	370	220	273	.444	.51

Winooski River at Montpelier, Vt.

Location.—One mile downstream from the Central Vermont Railway station in Montpelier, Washington County, about three-eights mile above mouth of Dog River, and 1¼ miles below mouth of Worcester Branch.

Drainage area.—420 square miles.

Records available.—May 19, 1909, to September 30, 1920.

Gage.—Gurley seven-day water-stage recorder on right bank, installed July 4, 1914; gage heights referred to datum by means of a hook gage inside the well; an outside staff gage is used for auxiliary readings. Recorder inspected by L. D. Smith.

Discharge measurements.—Made from a cable or by wading.

Channel and control.—Channel deep and fairly uniform in section at the gage; control is formed by sharply defined rock outcrop about 500 feet below gage.

Extremes of discharge.—1909-1920: Maximum stage determined by levelling from flood marks preserved on building near present gage, 17.31 feet, April 7, 1912 (discharge not determined); minimum stage from water-stage recorder 1914-1918, 2.77 feet, August 13, 1914, and October 24, 1915 (discharge, 19 second-feet).

Ice.—Stage-discharge relation affected by ice during the winter months. Discharge ascertained by means of gage heights, current-meter measurements, observer's notes, and climatic records.

Regulation.—Operation of power plants on main stream and tributaries above station cause diurnal fluctuations in stage.

Accuracy.—Stage-discharge relation practically permanent except when affected by ice. Rating curve well defined between between 30 and 5,000 second-feet. Operation of water-stage recorder satisfactory throughout the year. Daily discharge determined by application of rating table to mean daily gage heights, with corrections for effect of ice during winter months.

Discharge measurements of Winooski River at Montpelier, Vt., during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
Jan. 23	H. W. Fear	(a) 4.36	420
Mar. 1	M. R. Stackpole	(a) 4.44	397
June 25	R. H. Suttie	3.57	179
Nov. 21	H. S. Price	4.26	452
1920			
Jan. 15	H. S. Price	(a) 4.55	276

(a)Stage-discharge relation affected by ice.

Daily discharge in second-feet of Winooski River at Montpelier, Vt., for the years ending Sept. 30, 1919 and 1920

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	520	2,180	720	630	300	660	1,460	900	450	190	110	118
2	420	1,540	650	900	280	1,700	1,260	1,140	420	180	116	188
3	870	1,220	640	830	390	1,340	1,140	1,080	390	172	93	142
4	720	1,140	640	740	320	1,000	1,140	980	350	131	108	124
5	1,260	1,220	620	630	280	1,550	1,500	1,260	320	154	110	150
6	6,600	1,060	530	540	280	1,720	2,400	1,140	290	120	132	92
7	3,600	970	490	510	270	1,060	3,350	880	340	174	188	62
8	1,600	890	560	510	220	860	3,000	910	330	194	170	132
9	1,160	560	550	500	220	770	2,150	720	365	160	122	580
10	950	970	550	480	280	1,340	1,840	640	540	142	67	340
11	860	940	500	470	260	1,040	1,980	620	370	150	120	240
12	720	780	460	470	230	780	5,900	670	305	134	114	930
13	660	690	440	470	210	710	2,600	600	230	80	94	1,730
14	760	680	620	470	210	700	2,100	520	225	130	90	560
15	600	670	1,680	440	220	640	1,720	450	260	150	94	345
16	550	640	1,280	420	210	560	1,500	400	315	158	100	275
17	510	610	790	420	220	465	1,820	650	540	172	78	250
18	1,240	1,240	660	400	240	800	1,760	1,700	315	150	126	210
19	950	3,900	640	370	240	1,200	1,480	1,020	250	118	118	210
20	730	1,680	610	370	220	1,540	1,380	740	295	61	124	190
21	1,360	1,240	490	340	220	2,550	1,300	620	290	106	102	156
22	970	1,080	510	340	210	2,350	1,140	2,250	220	128	88	190
23	730	900	1,680	340	180	1,440	1,040	4,000	230	150	96	230
24	640	830	1,340	860	220	1,440	1,000	1,900	200	142	66	235
25	580	740	1,380	930	220	1,420	1,180	1,380	180	130	130	225
26	960	600	1,240	750	230	1,440	1,040	1,180	180	120	124	260
27	1,000	600	860	590	260	1,760	920	1,000	300	178	140	230
28	800	630	690	500	240	8,000	870	830	425	96	146	136
29	730	970	550	380	.....	3,400	1,040	690	240	112	130	154
30	1,960	940	465	320	.....	2,300	1,060	610	230	126	114	112
31	6,000	.....	430	320	.....	1,780	.....	530	.....	114	54	.....
1919-20												
1	108	1,460	1,040	300	230	210	2,060	1,970	272	494	198	237
2	126	909	664	320	240	210	2,670	1,700	244	276	204	264
3	1,680	626	470	310	220	210	3,120	1,540	268	312	168	195
4	937	500	506	310	230	190	2,430	1,460	228	560	155	145
5	818	671	548	290	210	200	2,850	1,250	204	482	131	108
6	1,440	755	494	290	230	300	3,290	1,130	272	304	120	115
7	1,380	727	435	280	230	330	1,790	1,080	365	225	120	210
8	650	734	488	270	210	380	1,440	1,030	300	405	49	536
9	405	664	590	300	200	360	1,200	1,240	234	300	131	350
10	644	602	1,180	310	230	220	1,160	1,050	210	222	120	268
11	1,110	650	902	280	230	320	1,200	902	175	178	470	410
12	825	1,000	727	260	220	370	1,150	790	170	204	530	320
13	566	2,580	699	250	220	1,650	4,500	706	126	189	350	1,100
14	410	1,460	1,340	240	190	1,250	5,020	671	180	244	560	900
15	360	979	965	220	200	1,000	2,330	755	148	455	692	650
16	460	706	692	220	240	800	3,910	632	225	276	930	435
17	660	685	572	230	240	1,200	2,990	596	213	186	560	455
18	420	678	520	220	240	1,300	2,420	542	204	145	300	445
19	400	671	480	220	240	840	2,130	494	272	320	237	965
20	385	584	380	220	230	720	2,220	476	225	518	201	560
21	330	518	400	220	240	560	2,410	506	231	280	165	390
22	776	566	400	220	200	460	4,810	1,100	276	276	160	325
23	572	874	380	220	210	540	4,070	839	210	280	276	284
24	415	769	370	230	220	1,350	4,630	638	195	240	210	260
25	385	590	360	220	210	2,600	2,660	584	165	186	195	200
26	365	554	390	220	200	7,890	1,920	482	143	198	143	180
27	500	554	360	220	200	7,640	2,700	405	84	180	136	220
28	506	488	340	230	200	5,090	3,540	355	153	168	117	280
29	500	470	380	230	195	3,430	3,460	292	145	160	90	370
30	385	1,410	360	230	.....	3,030	2,650	284	506	400	160	600
31	867	.....	360	220	.....	2,370	.....	268	.....	320	141	.....

Monthly discharge of Winooski River at Montpelier, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 420 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	6,000	420	1,320	3.14	3.62
November	3,900	600	1,070	2.55	2.84
December	1,680	430	751	1.79	2.06
January	930	320	524	1.25	1.44
February	390	180	246	.586	.61
March	8,000	465	1,560	3.71	4.28
April	3,350	870	1,740	4.14	4.62
May	2,250	400	1,030	2.45	2.82
June	450	180	313	.745	.83
July	194	61	139	.331	.38
August	188	54	112	.267	.31
September	1,730	62	293	.698	.78
The year	8,000	54	761	1.81	24.59
1919-20					
October	1,680	108	625	1.49	1.72
November	2,580	470	815	1.94	2.16
December	1,340	340	574	1.37	1.58
January	320	220	252	.600	.69
February	240	190	219	.521	.56
March	7,890	190	1,520	3.62	4.17
April	5,020	1,150	2,760	6.57	7.33
May	1,970	268	831	1.98	2.28
June	506	84	221	.526	.59
July	560	145	290	.690	.80
August	930	49	259	.617	.71
September	1,100	108	391	.931	1.04
The year	7,890	49	729	1.74	23.63

Dog River at Northfield, Vt.

Location.—At highway bridge near Norwich University campus in Northfield, Washington County. Union Brook joins Dog River at a short distance below station.

Drainage area.—47 square miles.

Records available.—May 14, 1909, to September 30, 1920. Records from May 14, 1909, to August 22, 1910, obtained at lower highway bridge; those from August 23, 1910, to date, at present location.

Gage.—Inclined staff on left bank read by Florence C. Doyle.

Discharge measurements.—Made from highway bridge or by wading.

Channel and control.—Channel composed of gravel and alluvial deposits; subject to slight shifts. Banks overflow at high stages.

Extremes of discharge.—1910-1920: Maximum stage recorded at present site, 8.5 feet, March 25, 1913 (discharge 3,400 second-feet); minimum stage recorded, 0.60 foot, September 10 and 11, 1913 (discharge, 3.0 second-feet). At the lower gage, 1909-10, flow was practically zero at various times when water was held back by dam.

Ice.—River usually freezes over, and the stage-discharge relation is slightly affected by ice during some winters; probably not affected by ice during winter of 1918-19 or 1919-20.

Accuracy.—Stage-discharge relation changed slightly during the year and two rating curves were used. Rating curves well defined below 600 second-feet. Gage read to quarter-tenths daily except during winter, when it was read once daily. Daily discharge ascertained by applying rating table to mean daily gage heights. Results good for discharge below 600 second-feet; results somewhat uncertain for high stages as banks overflow at a discharge of about 2,000 second-feet.

Discharge measurements of Dog River at Northfield, Vt., during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
Jan. 23	H. W. Fear	1.60	53
Mar. 1	M. R. Stackpole	2.46	150
June 25	R. H. Suttie	1.41	20.8
1920			
Jan. 16	H. S. Price	1.47	25.8
Aug. 20	J. L. Lamson	1.57	12.3
Aug. 20	J. L. Lamson	1.67	25.5

Daily discharge, in second-feet, of Dog River at Northfield, Vt., for the years ending Sept. 30, 1919 and 1920

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	70	257	107	125	56	157	256	104	90	21	14	14
2	62	192	116	155	51	130	215	172	88	19	9	15
3	108	169	107	130	56	109	184	122	76	18	9	15
4	79	181	96	110	51	130	194	129	65	16	7	14
5	130	155	86	107	49	228	404	148	221	15	7	11
6	527	132	90	104	42	217	417	125	61	21	18	10
7	266	121	86	100	38	196	513	124	64	24	15	10
8	164	121	86	93	45	161	430	108	56	19	15	9
9	135	106	80	96	51	143	350	97	84	15	14	39
10	108	107	74	100	58	161	297	90	77	15	11	23
11	104	104	74	96	49	136	377	106	56	16	8	21
12	92	94	68	93	45	119	404	103	48	14	7	53
13	90	86	63	100	40	109	363	85	48	14	8	196
14	85	80	80	96	38	153	310	76	49	14	9	40
15	75	79	249	90	32	139	260	71	48	17	13	33
16	69	73	141	90	36	67	242	65	42	16	14	27
17	63	69	93	93	40	20	310	109	37	15	9	23
18	138	119	104	80	36	91	284	230	35	14	9	19
19	90	700	74	68	36	106	234	137	29	13	13	16
20	86	268	80	66	32	242	207	109	34	11	14	18
21	148	205	78	58	30	417	215	114	34	14	12	19
22	119	172	80	47	24	310	178	541	26	20	10	21
23	90	153	270	49	28	217	161	444	24	19	9	23
24	79	138	245	58	28	249	157	377	26	15	12	21
25	78	124	194	86	24	242	148	272	21	14	15	33
26	90	125	158	80	24	238	141	225	20	13	18	29
27	85	122	125	74	26	390	120	200	65	12	15	26
28	75	104	107	66	32	2,360	114	161	40	13	13	23
29	75	181	110	56	.....	805	125	132	34	12	12	19
30	130	125	114	49	.....	527	122	106	26	12	11	18
31	471	.....	119	54	.....	323	.....	91	.....	10	14	.....
1919-20												
1	17	84	157	38	20	19	284	260	41	35	25	35
2	18	75	125	40	19	20	336	260	40	25	23	14
3	186	67	109	40	24	20	272	238	41	79	14	8
4	109	65	84	40	22	19	256	228	30	64	16	8
5	77	88	65	35	20	24	363	176	43	56	14	9
6	80	71	67	34	20	44	336	176	64	43	10	14
7	66	92	84	32	24	40	249	152	56	25	7	35
8	52	85	83	32	24	32	256	140	47	51	6	14
9	52	77	106	34	26	35	242	160	41	41	4	12
10	39	78	178	34	24	40	207	140	30	30	11	16
11	49	84	114	35	22	42	192	128	28	20	90	36
12	42	153	85	30	20	88	180	116	27	17	34	53
13	39	363	180	30	22	1,630	1,310	114	23	41	27	116
14	35	172	228	30	22	740	404	132	17	34	16	64
15	35	141	129	27	26	880	390	107	30	53	38	34
16	42	119	91	27	27	260	1,540	98	82	27	28	30
17	83	116	77	30	24	990	830	92	70	18	23	27
18	56	106	71	27	20	527	350	80	59	14	17	20
19	55	100	65	30	22	390	336	73	77	60	14	47
20	55	77	65	27	24	310	363	76	48	53	12	28
21	56	75	63	24	24	228	431	107	61	34	8	23
22	91	85	59	22	26	196	640	150	56	30	11	20
23	91	132	65	20	26	238	541	116	41	23	18	27
24	56	94	59	20	27	260	485	98	35	23	12	18
25	48	91	59	22	24	272	417	95	43	20	8	13
26	54	88	49	20	20	640	260	82	28	14	9	16
27	63	91	40	26	19	1,050	284	73	23	10	14	13
28	88	75	40	24	20	880	284	65	23	10	14	14
29	83	77	44	24	17	585	284	59	41	8	14	14
30	56	260	44	22	.....	499	272	53	28	25	13	79
31	78	.....	40	22	.....	349	.....	47	.....	34	14	.....

Monthly discharge of Dog River at Northfield, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 47 square miles.)

MONTH	DISCHARGE IN SECOND FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	527	62	128	2.72	3.14
November	700	69	155	3.30	3.68
December	270	63	115	2.45	2.82
January	155	47	86.1	1.83	2.11
February	58	24	39.2	.834	.87
March	2,360	20	287	6.11	7.04
April	513	114	258	5.49	6.12
May	541	65	160	3.40	3.92
June	221	20	54.1	1.15	1.28
July	24	10	15.5	.330	.38
August	18	7	11.7	.249	.29
September	196	9	27.9	.594	.66
The year	2,360	7	112	2.38	32.31
1919-20					
October	186	17	62.9	1.34	1.54
November	363	65	109	2.32	2.59
December	228	40	87.9	1.87	2.16
January	40	20	29.0	.617	.71
February	27	17	22.6	.481	.52
March	1,630	19	366	7.79	8.98
April	1,540	180	420	8.94	9.97
May	260	47	126	2.68	3.09
June	82	17	42.4	.902	1.01
July	79	8	32.8	.698	.80
August	90	4	18.2	.387	.45
September	116	8	28.6	.609	.68
The year	1,630	4	112	2.38	32.50

Lamoille River at Cadys Falls, Vt.

Location.—About one-fourth mile below plant of Morrisville Electric Light and Power Co., at what was formerly known as Cadys Falls, 2 miles downstream from village of Morrisville, Lamoille County.

Drainage area.—280 square miles.

Records available.—September 4, 1913, to September 30, 1920.

Gages.—Friez water-stage recorder in gage house on right bank one-fourth mile below highway bridge at Cadys Falls. Gage heights are referred to gage datum by means of a hook gage inside well; an outside staff gage is used for auxiliary readings. Recorder inspected by N. E. Cobleigh.

Discharge measurements.—Made from a cable or by wading.

Channel and control.—Channel smooth gravel; well defined gravel control 500 feet downstream from gage.

Extremes of discharge.—1913-1920. Maximum stage recorded, 10.77 feet, April 12, 1919 (discharge from extension of rating curve 7,530 second-feet); minimum stage recorded, 1.39 feet, August 6, 1919 (discharge from extension of rating curve, 5 second-feet) (water held back by dam).

Ice.—River freezes over during extremely cold weather; stage-discharge relation slightly affected by ice. Discharge determined from gage heights with corrections for backwater based on current-meter measurements, observer's notes, and climatic records.

Accuracy.—Stage-discharge relation practically permanent, except when affected by ice. Rating curve well defined. Operation of water-stage recorder satisfactory throughout year except for clock stopping frequently during January, February and March. Daily discharge ascertained by discharge integrator. Results good.

Discharge measurements of Lamoille River at Cadys Falls, Vt., during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
Jan. 5	R. H. Suttie	(a) 2.93	359
5	R. H. Suttie	(a) 2.91	344
20	H. W. Fear	(a) 2.64	277
Feb. 24	M. R. Stackpole	2.47	219
1920			
Feb. 20	H. S. Price	(a) 2.75	210

(a) Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Lamoille River at Cadys Falls, Vt., for the years ending Sept. 30, 1919 and 1920.

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	435	1,840	365	440	300	240	880	650	235	146	96	148
2	370	1,060	325	670	350	600	720	790	235	154	91	136
3	360	790	385	640	184	550	690	760	230	138	40	124
4	370	700	435	520	155	500	640	670	154	100	52	126
5	560	700	410	440	150	700	740	1,060	150	128	65	118
6	4,000	650	330	400	150	700	1,340	920	220	118	69	110
7	3,250	550	325	400	140	500	2,700	660	330	152	80	75
8	1,060	550	315	370	300	480	2,450	700	290	138	69	136
9	485	600	375	340	250	430	1,900	560	260	126	90	160
10	640	700	320	280	240	680	1,420	450	345	122	52	170
11	630	910	270	260	190	600	1,940	415	270	130	110	152
12	305	190	300	260	190	480	5,600	435	215	114	100	460
13	355	170	325	260	220	520	2,250	390	185	63	98	790
14	490	435	485	260	190	550	1,700	345	168	124	110	350
15	430	430	1,500	240	190	480	1,340	315	198	120	98	220
16	400	400	1,050	260	210	355	1,200	290	580	134	84	184
17	365	400	660	255	230	340	1,600	355	880	124	40	162
18	620	740	480	290	190	410	1,480	1,060	445	124	104	154
19	680	1,500	390	300	190	580	1,220	740	275	124	104	146
20	560	1,080	350	295	200	830	1,000	500	360	85	104	130
21	1,100	790	320	280	210	1,760	1,140	400	300	126	106	112
22	600	690	395	280	220	1,840	730	910	200	130	112	170
23	450	610	1,600	290	240	1,040	770	1,880	180	104	100	285
24	450	700	1,180	530	250	920	720	1,480	166	150	51	190
25	470	550	840	720	275	950	880	1,000	154	130	106	188
26	500	370	770	500	260	1,040	700	1,080	150	172	120	235
27	600	350	570	460	240	1,460	650	770	235	54	82	190
28	460	365	500	400	275	3,550	690	440	300	110	94	142
29	440	650	440	400	.....	2,050	770	435	215	106	110	156
30	1,420	950	420	400	.....	1,460	840	465	176	104	120	160
31	4,900	.....	335	350	.....	1,100	.....	380	.....	108	112	.....
1919-20												
1	150	1,980	790	196	72	245	1,240	1,400	184	152	124	180
2	154	1,000	520	196	132	240	1,660	1,170	174	150	120	230
3	430	700	390	185	172	250	2,150	1,060	170	142	108	210
4	340	560	320	112	165	240	1,800	990	174	60	90	175
5	250	580	370	205	155	210	1,900	820	166	154	100	95
6	1,140	630	300	245	172	270	2,500	740	60	154	88	120
7	1,140	600	295	216	112	310	1,300	730	104	138	93	162
8	500	580	340	216	52	290	980	730	142	280	33	260
9	335	540	340	162	172	270	770	840	172	205	86	215
10	610	490	720	140	172	235	700	830	176	158	100	190
11	2,300	540	570	112	165	310	750	630	154	96	182	172
12	1,100	800	500	172	155	340	770	560	136	140	180	112
13	610	2,400	530	205	140	1,000	3,000	540	60	132	156	330
14	465	1,360	930	205	112	1,050	3,500	480	132	132	580	570
15	370	850	620	200	52	930	1,760	370	150	132	760	450
16	370	590	475	200	126	770	2,850	300	150	130	340	380
17	540	570	345	195	135	1,200	2,150	300	156	140	265	440
18	450	550	270	126	140	1,140	1,880	300	130	66	230	450
19	320	540	255	195	140	1,120	1,580	295	156	142	210	700
20	300	480	210	220	135	830	1,860	270	73	330	220	440
21	310	400	170	205	112	530	1,860	255	154	278	188	350
22	900	455	235	172	85	485	2,800	740	160	205	92	265
23	620	930	220	172	140	620	2,650	630	174	168	275	275
24	400	760	200	195	185	1,260	3,500	520	170	150	225	220
25	360	570	132	85	225	1,880	2,150	450	162	140	154	195
26	335	510	182	165	230	3,900	1,350	375	150	148	160	120
27	460	510	182	140	235	550	1,200	320	70	136	186	200
28	490	340	100	126	205	3,000	2,150	210	134	124	190	196
29	500	360	224	126	112	2,250	2,350	194	152	110	85	265
30	390	910	205	140	.....	1,960	1,980	184	150	140	150	560
31	1,520	.....	211	126	.....	1,520	.....	190	.....	162	150	.....

Monthly discharge of Lamoille River at Cadys Falls, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 280 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	4,900	305	895	3.20	3.69
November	1,840	170	681	2.43	2.71
December	1,600	270	541	1.93	2.22
January	670	240	380	1.36	1.57
February	350	140	221	.789	.82
March	3,550	240	893	3.19	3.68
April	5,600	640	1,360	4.86	5.42
May	1,880	290	687	2.45	2.82
June	880	150	270	.964	1.08
July	154	54	121	.432	.50
August	120	40	89.3	.319	.37
September	460	75	196	.700	.78
The year	5,600	40	5,290	1.89	25.66
1919-20					
October	2,300	150	586	2.09	2.41
November	2,400	340	736	2.63	2.93
December	930	100	360	1.28	1.48
January	245	85	173	.618	.71
February	235	52	145	.518	.56
March	3,900	210	942	3.36	3.87
April	3,500	700	1,900	6.79	7.58
May	1,400	184	562	2.00	2.30
June	184	60	143	.511	.57
July	330	60	155	.554	.64
August	760	33	191	.682	.79
September	700	95	284	1.01	1.13
The year	3,900	33	514	1.84	24.97

Green River at Garfield, Vt.

Location.—At site of old dam above highway bridge at Garfield village, town of Hyde Park, Lamoille County. Green River is tributary to Lamoille River about 4 miles east of Morrisville.

Drainage area.—20 square miles (approximate).

Records available.—January 3, 1915, to September 30, 1920.

Gage.—Inclined staff on left bank in pool back of weir; read by P. M. Trescott.

Discharge measurements.—Standard sharp-crested weir of compound section; length of crest at gage height 0.00 is 9.0 feet; at gage height 0.83 foot, length of crest is increased 11.17 feet. Current-meter measurements made at foot-bridge about one-half mile downstream from weir, and at old bridge about one-half mile above weir.

Channel and control.—A pool of considerable size is formed in the old mill pond back of the weir; at ordinary stages the velocity of approach to the weir is very small. Some water leaks around the weir in the old tail-race on left bank.

Extremes of discharge.—1915-1920: Maximum stage (determined from high water marks). 4.63 feet on April 12, 1919 (approximate discharge from extension of rating curve, 710 second-feet); minimum stage recorded, 0.20 foot August 8 and 9, 1919 (discharge 2.7 second-feet).

Ice.—Weir and weir crest kept clear of ice during winter; stage-discharge relation not affected by ice.

Regulation.—An old timber dam about 2 miles upstream affects flow to some extent. The dam leaks by an amount somewhat greater than the low-water flow. During prolonged low stages the surface of water in pond (103 acres) falls below crest of dam; subsequent increased flow into pond is retained until water again flows over crest, when the increased flow is apparent at gaging station.

Accuracy.—Stage-discharge relation practically permanent. Rating curve based on weir formula, $Q = 3.33 LH^{3/2}$ with corrections determined from current-meter measurements, and with logarithmic extension above gage height 1.90 feet. Gage read twice daily to hundredths. Daily discharge ascertained by applying rating table to mean daily gage heights. Results are good below 130 second-feet; at the higher stages the weir is flooded and results are somewhat uncertain.

Discharge measurements of Green River at Garfield, Vt., during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
June 21	(a) R. H. Suttie	0.82	23.7
21	(b) R. H. Suttie	.81	23.6
1920			
Aug. 16	(a) J. L. Lamson	.76	20.7
16	(b) J. L. Lamson	.74	18.6

(a) Made at old bridge about one-half mile above gage.

(b) Made at section just above Taylor Brook, about one-half mile below gage.

Daily discharge, in second-feet, of Green River at Garfield, Vt., for the years ending Sept. 30, 1919 and 1920

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	40	170	39	23	14	14	61	56	24	14	6.6	9.3
2	32	90	33	30	14	13	50	64	21	13	6.3	8.7
3	29	66	28	30	14	12	39	61	19	12	6.0	8.4
4	28	51	26	28	14	12	36	55	18	12	6.0	8.0
5	37	47	25	27	13	15	38	69	16	11	5.7	7.7
6	110	43	22	24	13	14	50	69	16	12	9.3	7.7
7	253	38	22	22	12	14	102	52	46	12	7.1	7.7
8	101	37	21	21	12	13	164	45	52	11	6.6	7.7
9	54	35	20	20	12	16	145	38	36	11	6.0	10
10	44	38	18	18	12	20	130	32	35	11	5.7	8.7
11	37	53	16	16	11	18	135	30	27	10	5.7	8.7
12	32	40	17	17	11	19	610	28	24	10	5.5	17
13	29	34	17	16	11	23	246	26	20	10	5.2	25
14	28	31	21	15	10	25	169	24	19	9.3	5.2	23
15	27	28	40	15	12	22	127	21	21	10	6.0	21
16	25	26	54	16	12	20	104	19	35	13	5.5	19
17	23	25	37	16	11	18	107	29	99	9.3	4.9	18
18	34	43	29	16	10	20	126	71	61	9.0	4.9	17
19	33	89	27	16	11	21	103	55	34	8.7	6.6	16
20	34	139	25	15	11	26	93	38	38	8.4	5.5	15
21	72	70	23	15	12	44	93	31	24	8.7	4.9	14
22	70	51	25	14	11	67	77	47	19	9.3	5.2	17
23	46	44	65	14	11	74	67	148	17	8.4	4.7	17
24	36	42	127	20	11	63	60	88	16	8.0	6.3	17
25	32	34	80	14	11	62	60	104	15	7.7	5.2	17
26	37	27	54	19	10	62	52	130	14	7.4	4.9	18
27	49	24	37	19	10	81	46	76	23	7.7	5.2	18
28	43	23	36	18	11	141	50	50	16	7.1	9.3	16
29	35	31	32	16	.....	152	59	39	14	9.0	9.3	15
30	112	43	27	16	.....	107	71	34	14	8.0	9.0	14
31	352	.....	24	15	.....	86	.....	28	.....	6.9	9.7	.....
1919-20												
1	14	241	43	12	7.7	8.7	103	153	11	6.3	9.0	5.7
2	14	106	40	12	8.0	8.4	100	118	10	6.3	7.4	7.7
3	25	65	36	12	7.7	8.4	128	111	9.3	10	5.5	6.9
4	14	48	30	11	7.7	8.7	130	100	8.7	18	4.6	5.5
5	19	45	25	12	7.4	8.7	128	91	8.4	20	3.8	4.7
6	36	40	22	11	7.4	9.7	142	81	9.3	16	3.4	4.7
7	39	38	23	11	7.4	9.3	118	75	14	13	2.9	6.3
8	47	36	21	11	7.4	9.0	85	71	13	24	2.7	7.4
9	34	34	26	11	7.1	8.7	63	71	12	24	2.7	5.7
10	51	32	26	11	7.1	9.0	54	60	11	15	2.9	5.7
11	204	38	32	10	7.1	9.3	54	54	8.7	14	8.0	6.3
12	122	42	31	11	7.4	10	54	50	7.4	11	12	12
13	75	139	31	10	7.4	12	116	47	6.3	10	18	23
14	50	143	37	10	7.4	12	273	37	5.7	9.3	29	25
15	39	71	43	10	8.0	12	141	30	6.0	8.0	25	21
16	35	49	32	9.7	8.0	12	174	26	5.7	6.3	19	19
17	37	41	22	10	8.0	13	172	23	5.2	4.9	14	21
18	32	39	17	9.7	7.7	14	162	20	5.2	4.2	11	26
19	29	39	17	9.7	8.0	13	148	18	5.7	15	8.0	28
20	26	34	16	9.7	8.0	13	191	16	5.7	21	6.3	26
21	24	30	16	9.3	8.0	14	174	15	6.6	24	5.2	21
22	31	30	14	9.3	8.0	16	172	50	6.9	19	11	15
23	47	40	15	10	8.7	24	199	55	6.9	13	11	12
24	49	45	14	9.3	8.7	29	302	50	6.3	11	12	11
25	37	41	13	9.0	8.7	39	164	42	4.9	11	11	8.7
26	34	36	14	9.0	8.7	57	123	33	4.7	10	8.0	7.4
27	34	32	16	9.0	8.0	138	102	27	4.2	10	6.3	6.9
28	38	30	17	8.7	8.4	191	126	23	4.0	9	5.2	11
29	40	27	14	8.7	8.7	136	150	19	4.9	9	4.2	11
30	35	39	13	8.4	.....	123	162	16	4.9	12	3.8	13
31	109	.....	12	8.0	.....	116	.....	12	.....	10	3.6	.....

Monthly discharge of Green River at Garfield, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 20 (approx.) square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	352	23	61.7	3.09	3.56
November	170	23	50.4	2.52	2.81
December	127	16	34.4	1.72	1.98
January	30	14	18.7	.935	1.08
February	14	10	11.7	.585	.61
March	152	12	41.7	2.09	2.41
April	610	36	109	5.45	6.08
May	148	19	53.5	2.67	3.08
June	99	14	27.8	1.39	1.55
July	14	6.9	9.84	.492	.57
August	9.7	4.7	6.25	.313	.36
September	25	7.7	14.2	.710	.79
The year	610	4.7	36.7	1.83	24.88
1919-20					
October	204	14	45.8	2.29	2.64
November	241	27	55.7	2.78	3.10
December	43	12	23.5	1.18	1.36
January	12	8.0	10.1	.505	.58
February	8.7	7.1	7.86	.393	.42
March	191	8.4	35.2	1.76	2.03
April	302	54	140	7.00	7.81
May	153	12	51.4	2.57	2.96
June	14	4.0	7.42	.371	.41
July	24	4.2	12.7	.635	.73
August	29	2.7	8.92	.446	.51
September	28	4.7	12.8	.640	.71
The year	302	2.7	34.2	1.71	23.26

Missisquoi River near Richford, Vt.

Location.—About three miles downstream from Richford, Franklin County, 3 miles below mouth of North Branch, and 2 miles above mouth of Trout River.

Drainage area.—445 square miles.

Records available.—May 22, 1909, to December 3, 1910, and June 26, 1911, to September 30, 1920.

Gage.—Gurley water-stage recorder on left bank, about one-fourth mile above highway bridge, inspected by P. Sloan until March 20, 1920, and by Harry Jenne after June 24; chain gage on highway bridge used from June 26, 1911, to July 31, 1915. From May 22, 1909, to December 3, 1910, gage was just below plant of the Sweat-Comings Co. in Richford.

Discharge measurements.—Made from highway bridge or by wading.

Channel and control.—Channel deep, banks not subject to over-flow; stream bed composed of gravel, boulders and ledge rock. Control is sharply defined by rock outcrop about 100 feet below gage.

Extremes of discharge.—1911-1920: Maximum stage recorded, 17.64 feet on April 1, 1918 (stage-discharge relation affected by ice); minimum stage recorded, 4.15 feet by chain gage, July 14, 1911 (discharge, 8 second-feet).

Ice.—Stage-discharge relation usually affected by ice, from December to March; discharge determined from gage heights corrected for effect of ice by means of current-meter measurements, observer's notes, and weather records.

Regulation.—Considerable daily fluctuation at low stages caused by operation of power plants at Richford.

Accuracy.—Stage-discharge relation practically permanent except when affected by ice. Rating curve fairly well defined below 6,000 second-feet. Gage house wrecked by ice March 21, 1920, and rebuilt June 23; operation of water-stage recorder satisfactory during remainder of the year 1920. Operation of recorder not entirely satisfactory prior to March 20, 1920, on account of carelessness of observer. Daily discharge ascertained by applying rating table to mean daily gage heights determined by inspection of recorder sheets, with correction for effect of ice during winter. Results good for open water periods, and fair for the winter.

Discharge measurements of Missisquoi River near Richford, Vt., during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1918		Feet	Sec.-ft.
Nov. 30	R. H. Suttie	5.91	2,130
1919			
Jan. 16	H. W. Fear	(a) 5.67	469
17	H. W. Fear	(a) 5.57	414
Feb. 26	M. R. Stackpole	(a) 4.27	302
June 24	R. H. Suttie	2.90	227
1920			
Jan. 19	H. S. Price	(a) 4.34	219
Feb. 21	H. S. Price	(a) 4.51	124
June 24	M. R. Stackpole	2.95	239

(a) Stage-discharge relation affected by ice.

Daily discharge, in second-feet of Missisquoi River near Richford, Vt., for the years ending Sept. 30, 1919 and 1920

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	1,480	6,720	1,480	1,920	400	480	1,360	1,440	375	200	95	343
2	1,170	3,830	1,170	2,100	400	860	925	1,640	343	179	100	317
3	2,200	1,880	1,680	2,100	400	920	1,130	1,560	303	160	88	237
4	1,560	1,440	1,640	2,000	400	860	1,100	1,400	265	145	105	197
5	1,440	1,360	1,240	1,800	375	1,360	1,030	1,800	237	140	102	197
6	7,870	1,200	1,170	1,600	335	1,320	2,010	1,720	233	115	95	155
7	7,610	960	1,100	1,440	320	770	5,280	1,640	247	135	125	170
8	4,820	960	1,030	1,280	280	830	4,600	1,480	446	140	115	437
9	2,240	925	1,030	1,140	280	830	3,500	1,170	355	140	107	1,100
10	1,400	1,130	960	1,000	265	1,240	2,440	860	324	120	112	1,030
11	1,060	1,400	925	900	265	1,680	3,720	770	282	122	135	1,170
12	890	995	890	800	265	1,400	8,000	710	247	120	110	1,920
13	830	800	890	700	250	1,400	7,220	650	215	120	105	4,160
14	860	740	2,150	620	250	1,030	4,820	595	317	110	100	3,500
15	830	710	4,160	550	280	830	3,060	541	662	120	93	1,280
16	710	698	2,950	460	265	710	2,340	500	770	200	125	740
17	565	740	1,760	400	280	710	3,060	650	2,240	221	122	740
18	1,200	1,360	1,240	350	320	2,540	3,390	1,560	830	176	122	668
19	1,560	2,840	960	320	300	3,610	2,840	1,440	460	127	115	496
20	1,130	3,060	830	280	280	5,520	2,200	960	335	115	28	600
21	2,340	2,340	770	250	280	3,610	2,150	770	282	120	188	710
22	1,920	1,880	860	185	230	3,720	1,970	1,060	247	95	300	635
23	1,240	1,560	3,170	265	250	3,280	1,720	2,340	224	95	261	710
24	960	1,240	3,280	1,360	300	2,390	1,440	1,400	224	95	237	610
25	830	1,170	2,060	1,440	250	1,970	1,400	1,100	206	86	363	740
26	1,720	1,030	1,480	1,100	280	1,970	1,240	1,240	176	83	383	1,060
27	1,840	890	1,100	860	280	2,290	1,240	1,030	247	77	265	800
28	1,360	830	960	650	265	3,940	1,240	740	415	130	324	460
29	1,170	1,480	890	550	.....	3,720	1,400	595	300	122	367	505
30	5,280	2,200	830	500	.....	2,490	1,720	505	240	120	300	415
31	7,480	.....	1,680	460	.....	1,800	.....	424	.....	115	265	.....
1919-20												
1	335	7,740	1,970	260	.....	92	.....	.....	.....	890	800	145
2	282	5,520	1,140	270	.....	90	.....	.....	.....	460	500	268
3	1,760	2,840	770	260	.....	88	.....	.....	.....	656	335	268
4	1,880	1,000	960	210	.....	90	.....	.....	.....	1,520	303	188
5	1,170	1,640	1,200	230	.....	145	.....	.....	.....	1,640	261	145
6	3,060	1,640	1,950	190	.....	230	.....	.....	.....	1,030	233	115
7	2,240	1,520	1,900	230	.....	300	.....	.....	.....	960	203	145
8	2,390	1,400	1,700	230	.....	290	.....	.....	.....	1,800	179	282
9	1,560	1,320	1,550	250	.....	300	.....	.....	.....	1,520	188	343
10	1,920	1,200	2,800	240	.....	290	.....	.....	.....	890	157	275
11	2,240	1,640	1,700	220	.....	260	.....	.....	.....	605	162	203
12	2,150	2,440	1,500	230	.....	330	.....	.....	.....	446	209	203
13	1,280	4,710	1,800	230	.....	2,600	.....	.....	.....	505	227	321
14	920	4,160	2,300	210	.....	2,700	.....	.....	.....	455	227	585
15	740	2,440	1,700	210	.....	1,950	.....	.....	.....	363	215	411
16	645	1,520	1,350	220	.....	1,650	.....	.....	.....	293	240	314
17	860	1,170	940	200	.....	2,800	.....	.....	.....	237	194	960
18	890	1,170	720	185	.....	2,450	.....	.....	.....	221	179	1,060
19	704	1,170	640	175	.....	2,000	.....	.....	.....	2,150	132	925
20	625	1,180	420	170	.....	1,900	.....	.....	.....	3,170	132	740
21	630	1,250	400	.....	98	.....	.....	.....	.....	1,560	95	509
22	2,100	1,650	440	.....	98	.....	.....	.....	.....	960	132	399
23	1,840	2,020	460	.....	86	.....	.....	.....	.....	692	230	355
24	1,170	1,720	440	.....	125	.....	.....	.....	230	536	200	300
25	890	1,280	400	.....	76	.....	.....	.....	182	469	197	279
26	1,060	1,030	380	.....	100	.....	.....	.....	145	399	132	247
27	1,140	920	360	.....	96	.....	.....	.....	115	347	145	240
28	1,170	830	350	.....	100	.....	.....	.....	145	300	107	268
29	1,030	800	340	.....	82	.....	.....	.....	200	268	93	343
30	1,200	1,800	330	.....	.....	.....	.....	.....	1,360	383	132	460
31	5,040	.....	300	.....	.....	.....	.....	.....	.....	740	125	.....

Monthly discharge of Missisquoi River near Richford, Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 445 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	7,870	565	2,180	4.90	5.65
November	6,720	698	1,610	3.62	4.04
December	4,160	770	1,500	3.37	3.88
January	2,100	185	948	2.13	2.46
February	400	230	298	.670	.70
March	5,520	480	1,940	4.36	5.03
April	8,000	925	2,650	5.96	6.65
May	2,340	424	1,110	2.49	2.87
June	2,240	176	402	.903	1.01
July	221	77	130	.292	.34
August	383	28	173	.389	.45
September	4,160	155	870	1.96	2.19
The year	8,000	28	1,150	2.58	35.27
1919-20					
October	5,040	282	1,450	3.26	3.76
November	7,740	800	2,020	4.54	5.06
December	2,800	300	1,070	2.40	2.77
January	....	....	210	.472	.54
February	....	....	154	.346	.37
March 1-20	2,800	88	1,030	2.31	1.72
June 24-30	1,360	115	340	.764	.20
July	3,170	221	854	1.92	2.21
August	800	93	215	.483	.56
September	1,060	115	377	.847	.94

NOTE—Average discharge Jan 21-31, 1920, estimated 190 second-feet, and Feb. 1-20, 1920, estimated 180 second feet.

Clyde River at West Derby (Newport), Vt.

Location.—Just below plant of Newport Electric Light Co. at West Derby (Newport), Orleans County; about 1 mile above mouth of river.

Drainage area.—150 square miles.

Records available.—May 25, 1909, to September 30, 1920.

Gages.—Water-stage recorder on right bank; referenced to gage datum by a hook gage inside the well; chain gage fastened to tree is used for auxiliary readings. Recorder inspected by E. C. Rogers and F. R. Sherwell.

Discharge measurements.—Made by wading near gage or from highway bridge one-half mile downstream.

Channel and control.—Stream bed rough and irregular; covered with boulders and ledge rock; fall of river rapid for some distance below gage.

Extremes of discharge.—1909-1920; High water of March 25-30, 1913, reached maximum stage of 5.8 feet, as determined by engineers of Geological Survey from high-water marks (approximate discharge 6,300 second-feet); minimum stage 1.60 feet at 5:45 p. m. August 25, 1913, 7:30 p. m. July 30, and 4:50 p. m. August 17, 1914 (discharge, 17 second-feet).

Ice.—Ice usually covers large boulders below gage during greater part of winter, causing some backwater at the gage. Probably no effect from ice during winter of 1918-19.

Regulation.—Flow at ordinary stages fully controlled by two dams at West Derby, but power plant is so operated that fluctuations in stage are not great. Distribution of flow affected also by several dams above West Derby. Seymour Lake and several smaller ponds in the basin afford a large amount of natural storage, but at the present time there is little if any artificial regulation at these ponds.

Accuracy.—Stage-discharge relation practically permanent, except when affected by ice; individual current-meter measurements occasionally plot erratically, probably because of rough measuring section. Rating curve fairly well defined. Operation of water stage recorder unsatisfactory during a part of the year, as indicated in footnote to daily-discharge table. Daily discharge ascertained by applying rating table to mean daily gage heights, using observer's reading of chain gage when recorder was not in operation. Results fair.

Discharge measurements of Clyde River at West Derby (Newport), Vt. during the two-year period ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1918		Feet	Sec.-ft.
Dec. 1	R. H. Suttie	2.68	335
1919			
Jan. 17	H. W. Fear	2.43	227
Feb. 25	M. R. Stackpole	2.30	153
June 23	R. H. Suttie	2.52	240
1920			
June 25	M. R. Stackpole	2.28	144

Daily discharge, in second-feet, of Clyde River at West Derby (Newport), Vt., for the years ending Sept. 30, 1919 and 1920

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	532	1,280	328	264	.....	138	540	740	232	227	79	31
2	515	1,330	328	259	.....	93	523	740	259	227	113	44
3	490	1,300	340	264	.....	134	482	740	141	225	123	62
4	437	1,030	328	304	.....	145	482	710	196	225	128	60
5	374	850	292	300	.....	160	523	565	232	225	128	60
6	523	610	292	280	.....	182	523	760	232	225	107	71
7	684	540	260	260	.....	227	540	565	254	225	167	66
8	800	557	260	238	.....	218	655	482	238	227	298	60
9	910	557	240	227	.....	243	.....	498	254	164	218	62
10	498	702	220	220	.....	243	.....	445	269	81	128	48
11	628	684	210	220	.....	222	.....	482	238	85	113	64
12	655	548	190	220	.....	222	.....	467	191	99	182	220
13	565	490	170	215	.....	243	.....	374	164	81	81	200
14	548	467	170	210	.....	232	.....	482	149	113	53	280
15	374	440	149	210	.....	204	.....	280	182	128	50	390
16	310	415	152	210	.....	182	.....	310	145	120	44	350
17	540	415	213	204	.....	204	.....	320	138	113	44	340
18	674	430	367	204	.....	213	.....	330	128	91	53	290
19	565	437	353	204	.....	218	.....	340	91	85	44	240
20	225	380	340	204	.....	254	.....	353	81	83	37	220
21	227	318	298	204	.....	387	.....	374	81	83	37	180
22	340	259	298	145	.....	565	.....	400	105	85	50	190
23	400	298	275	145	.....	540	.....	498	204	93	51	230
24	445	310	286	152	.....	523	.....	482	238	102	51	200
25	353	394	380	150	138	523	.....	445	227	107	51	190
26	340	365	360	150	145	482	.....	422	204	67	60	60
27	353	340	360	150	145	482	637	422	191	67	60	220
28	540	340	394	145	145	523	523	415	145	67	160	60
29	374	350	400	145	.....	583	565	407	71	57	248	60
30	583	350	350	145	.....	583	702	310	167	62	200	200
31	1,100	.....	300	145	.....	583	.....	259	.....	69	145	.....
1920												
1									248	152	91	187
2									227	175	74	93
3									254	175	116	51
4									269	238	175	62
5									248	280	204	53
6									232	264	204	99
7									248	238	175	182
8									232	227	138	182
9									243	204	83	182
10									238	227	67	182
11									116	243	53	182
12									62	248	51	187
13									43	222	46	116
14									35	218	102	71
15									102	213	204	60
16									145	222	200	64
17									160	222	191	126
18									156	99	200	254
19									131	119	204	232
20									134	145	200	232
21									138	152	191	238
22									145	164	191	227
23									145	191	96	213
24								340	141	238	58	209
25								334	128	204	56	209
26								328	47	196	53	196
27								316	57	196	58	113
28								286	113	191	126	152
29								286	145	204	178	187
30								275	141	209	182	187
31								259	.....	196	187	.....

Note.—Water-stage recorder not in operation and discharge estimated: Oct. 8, 20, 23; Nov. 15, 26, 29, 30; Dec. 7-14, 29-31, 1918. Jan. 5-7, 10-16, 25-31; May 17, 18, 22; July 3-7, 16; Aug. 15, 22, 30; and Sept. 7-30, 1919 (chain gage read once daily).

Monthly discharge of Clyde River at West Derby, (Newport), Vt., for the years ending September 30, 1919 and 1920.

(Drainage area, 150 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	1,100	225	513	3.42	3.94
November	1,330	259	560	3.73	4.16
December	400	149	287	1.91	2.20
January	304	145	206	1.37	1.58
February	....	....	110	.733	.76
March	583	93	315	2.10	2.42
April	....	....	751	5.01	5.59
May	760	259	465	3.10	3.57
June	269	71	182	1.21	1.35
July	227	57	126	.840	.97
August	298	37	107	.713	.82
September	390	31	158	1.05	1.17
The year	1,330	31	316	2.11	28.53
1920					
May 24-31	340	259	303	2.02	.60
June	269	35	157	1.05	1.17
July	280	99	202	1.34	1.54
August	204	46	134	.893	1.03
September	254	51	158	1.05	1.17

Note—Average discharge Feb. 1-24, 1919, estimated 105 second-feet, and Apr. 9-26, 1919, estimated 880 second-feet.

Connecticut River at Fairlee, Vt. (Orford, N. H.)

Location.—At covered highway bridge between Fairlee, Vt., and Orford, N. H., approximately 8 miles downstream (by river) from mouth of Waits River and 22 miles above the mouth of White River.

Drainage area.—3,100 square miles.

Records available.—August 6, 1900, to September 30, 1920.

Gages.—Chain on upstream side of bridge and inclined staff on left bank 25 feet below bridge.

Discharge measurements.—Open-water measurements made from the bridge or from cable 500 feet above the bridge.

Channel and control.—Channel wide and deep, with gravelly bottom; control for high stages is probably at the dam at Wilder, 20 miles downstream.

Extremes of discharge.—1900-1920: Maximum stage recorded, 33.4 feet at 12 noon March 28, 1913 (approximate discharge by extension of rating curve, 57,300 second-feet); minimum 24-hour discharge 288 second-feet, September 28, 1909.

Ice.—Stage-discharge relation affected by ice, usually from December to March; ice cover usually remains in place throughout winter.

Regulation.—About 4,100 million cubic feet of storage has been developed at First and Second Connecticut Lakes and tributary streams above Pittsburgh. There are several power developments above the station, but the operation of these mills does not seriously affect the distribution of flow.

Accuracy.—Stage-discharge relation affected at times by use of flashboards at Wilder dam and during the winter by ice. Several rating curves have been used, each fairly well defined for period covered. Gage read to half-tenths twice daily. Daily discharge ascertained by applying rating table to mean daily gage heights, with corrections for ice during the winter. Results good. Precipitation records at St. Johnsbury, Vt., are given for purposes of comparison only, as it is not probable that records at St. Johnsbury indicate fairly the average rainfall in the upper Connecticut basin; the precipitation is probably considerably greater at places of higher altitude than along the river valley.

Monthly discharge of Connecticut River at Fairlee, Vt., (Orford, N. H.), for the two-year period ending Sept. 30, 1920.

(Drainage area, 3,100 square miles)

MONTH	Observed discharge (second-feet)			Gain or loss in storage at Connecticut Lakes (millions of cubic feet)	Discharge without storage (second-feet)		Run-off (depth in inches on drainage area)	Precipitation in inches at St. Johnsbury, Vt.
	Maximum	Minimum	Mean		Mean	Per square mile		
1918-19								
October	28,000	4,840	9,810	+1,103.3	10,200	3.29	3.79	7.60
November	28,900	4,610	9,630	+377.5	9,780	3.15	3.51	1.99
December	13,500	3,800	6,140	+25.6	6,150	1.98	2.28	2.79
January	6,100	3,000	4,130	−341.6	4,000	1.29	1.49	1.93
February	3,500	1,850	2,300	−1,104.9	1,840	.594	.62	1.71
March	28,400	3,200	8,980	−194.6	8,910	2.87	3.31	2.74
April	29,500	7,600	14,700	+922.6	15,100	4.87	5.43	2.53
May	13,700	4,610	8,950	+389.4	9,100	2.94	3.39	3.01
June	5,840	1,950	3,570	−541.8	3,360	1.08	1.20	2.82
July	4,100	960	1,720	−651.1	1,480	.477	.55	.96
August	1,620	910	1,230	−384.0	1,090	.352	.41	3.92
September	8,520	1,180	2,730	−28.6	2,720	.877	.98	2.59
The year	29,500	910	6,180	−428.2	6,170	1.99	26.96	34.59
1919-20								
October	8,050	1,600	4,650	+307.1	4,760	1.54	1.77	4.88
November	17,600	4,700	8,220	+752.1	8,510	2.75	3.07	3.10
December	10,600	2,350	4,990	+143.0	5,040	1.63	1.88	1.28
January	2,700	1,250	1,670	−1,454.7	1,130	.365	.42	1.59
February	1,220	980	1,090	−451.8	910	.294	.32	2.70
March	36,400	980	8,210	+92.3	8,240	2.66	3.07	3.14
April	32,800	9,470	22,700	+1,220.0	23,200	7.48	8.34	6.15
May	25,200	5,330	12,500	+884.7	12,800	4.13	4.76	1.67
June	5,960	1,580	3,120	−548.4	2,910	.939	1.05	3.14
July	5,650	1,580	3,140	+241.8	3,260	1.02	1.18	5.38
August	5,050	1,340	2,300	−742.1	2,020	.652	.75	1.73
September	7,000	1,970	3,280	−588.3	3,050	.984	1.10	7.38
The year	36,400	980	6,320	−144.3	6.320	2.04	27.71	42.14

PASSUMPSIC RIVER AT PIERCE'S MILLS, NEAR ST. JOHNSBURY, VT.

Location.—At suspension footbridge just below Pierce's mills, about 2 miles below mouth of Sheldon Branch, 4 miles above mouth of Moose River, and 5 miles north of St. Johnsbury, Caledonia County.

Drainage area.—237 square miles.

Records available.—May 26, 1909, to July 24, 1919.

Gage.—Staff, in two sections; low-water section a vertical staff bolted to ledge just above bridge; high-water section an inclined staff bolted to ledge below bridge; read by W. I. Cox, and Clinton G. Taylor.

Discharge measurements.—Made from footbridge or by wading below the bridge.

Channel and control.—Channel composed of ledge rock partly covered with gravel and alluvial deposits. At high stages the control is probably at the dam near Centervale.

Extremes of discharge.—Maximum stage recorded during year, 9.4 feet at noon October 31 (discharge by extension of rating curve, 4,320 second-feet); minimum stage recorded, 0.95 feet at 6:30 a. m. July 19 (discharge, 35 second-feet).

1909-1919: Maximum stage recorded, 14.8 feet during the night of March 27, 1913, determined by levelling from flood marks (discharge not computed); minimum stage recorded, zero flow at various times due to water being held back by mills.

Ice.—River freezes over at the control, causing the stage-discharge relation to be seriously affected; ice jams occasionally form below the gage.

Regulation.—An increased power development at Pierce's Mills by the construction of an hydro-electric power station at this place, has caused large fluctuations in discharge, and twice-a-day gage heights are considered insufficient for determination of mean daily discharge subsequent to July, 1919. Discharge previous to that time was not seriously affected by regulation.

Accuracy.—The stage-discharge relation has remained practically permanent, except when affected by ice. Rating curve fairly well defined below 2,000 second-feet. Gage read to quarter-tenths twice daily. Daily discharge ascertained by applying rating table to mean daily gage heights, with corrections for effect of ice during the winter. Results good.

Discharge measurements of Passumpsic River at Pierce's Mills, near St. Johnsbury, Vt., during the year ending Sept. 30, 1919.

DATE	MADE BY	Gage Height	Discharge
		Feet	Sec.-ft.
Jan. 18	H. W. Fear	(a) 2.34	281
Feb. 22	M. R. Stackpole	(a) 2.04	185
June 22	R. H. Suttie	1.73	190

(a) Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Passumpsic River at Pierce's Mills, near St. Johnsbury, Vt., for the year ending Sept. 30, 1919

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
1	360	1,560	420	560	260	560	530	710	230	164
2	320	1,040	420	670	230	800	460	910	216	164
3	375	870	460	710	180	660	530	790	230	141
4	360	670	420	560	230	520	670	750	202	141
5	360	750	390	530	200	520	870	1,000	202	130
6	2,600	710	360	500	210	540	950	830	176	120
7	1,880	670	360	500	220	370	1,460	670	360	141
8	910	600	340	460	210	260	1,610	710	320	128
9	640	640	320	410	195	280	1,170	600	260	117
10	530	640	320	390	185	680	1,120	500	290	111
11	500	670	320	340	185	660	1,610	500	245	111
12	460	670	320	360	185	500	2,860	460	202	109
13	420	600	360	370	185	410	1,710	460	189	109
14	560	630	420	360	180	405	1,460	405	164	97
15	500	460	1,040	300	170	360	1,080	360	245	68
16	420	460	710	310	150	340	1,080	390	320	141
17	375	460	420	300	165	360	1,510	530	910	109
18	870	1,120	390	280	175	460	1,410	1,260	420	69
19	600	640	320	280	165	530	1,080	750	275	35
20	600	530	305	280	170	750	910	530	260	89
21	1,120	710	290	260	190	1,510	1,000	460	202	61
22	670	640	390	250	180	1,510	910	530	176	99
23	530	530	1,310	300	190	750	830	1,000	176	141
24	460	500	1,000	1,100	200	750	790	640	164	68
25	460	460	750	830	210	710	790	530	164	.....
26	790	390	640	560	220	750	750	500	152	.....
27	830	390	460	500	220	830	710	420	460	
28	600	360	390	460	220	2,420	670	360	460	.....
29	530	460	375	380	.....	1,760	1,000	360	216	.....
30	2,300	750	375	380	.....	1,410	870	305	176	.....
31	3,770	.....	420	290	.....	750	.....	260	.....	.....

Monthly discharge of Passumpsic River at Pierce's Mills, near St. Johnsbury Vt., for the year ending September 30, 1919.

(Drainage area, 237 square miles)

MONTHS	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
October	3,770	320	829	3.50	4.04
November	1,560	360	649	2.74	3.06
December	1,310	290	478	2.02	2.33
January	1,100	250	445	1.88	2.17
February	260	150	196	.827	.86
March	2,420	260	746	3.15	3.63
April	2,860	460	1,080	4.56	5.09
May	1,260	260	596	2.51	2.89
June	910	152	269	1.14	1.27
July 1-24	164	35	111	.469	.42

White River at West Hartford, Vt.

Location.—About 500 feet above the highway bridge in the village of West Hartford, Windsor County, 7 miles above mouth of river.

Drainage area.—687 square miles.

Records available.—June 9, 1915, to September 30, 1920.

Gage.—Inclined staff on left bank; read by F. P. Morse.

Discharge measurements.—Made from cable 1,500 feet below the gage or by wading.

Channel and control.—Channel wide and of fairly uniform cross-section at measuring section; covered with gravel and small boulders. Control formed by rock ledge 100 feet below the gage; well defined.

Extremes of discharge.—1915-1920: Maximum stage recorded, 15.0 feet at 6 p. m. March 28, 1919 (approximate discharge by extension of rating curve, 20,500 second-feet); minimum stage recorded, 2.33 feet at 6 a. m. August 29, 1916 (approximate discharge by extension of rating curve, 26 second-feet). The high water of March 27, 1913, reached a stage of 19.9 feet, as determined from reference point on scale platform opposite gage (discharge not determined).

Ice.—River freezes over at the gage; control usually remains partly open, although ice on the rocks and along the shore affects the stage-discharge relation.

Regulation.—There are several power plants on the main stream and tributaries above the station, the nearest being that of the Vermont Copper Co. at Sharon; when this plant is in operation it causes some diurnal fluctuation in discharge at low stages. The effect of power plants farther upstream is eliminated by the large amount of pondage at Sharon.

Accuracy.—Stage-discharge relation practically permanent, except when affected by ice. Rating curve fairly well defined between 150 and 5,000 second-feet. Staff gage read to quarter-tenths twice daily. Daily discharge ascertained by applying rating table to mean daily gage heights, with corrections for effect of ice during the winter. Results good.

Discharge measurements of White River at West Hartford, Vt., during the two-years ending September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1918		Feet	Sec.-ft.
Oct. 29	R. H. Suttie	4.32	847
Nov. 5	R. H. Suttie	5.18	1,500
1919			
Jan. 22	H. W. Fear	(a) 4.26	729
Mar. 4	M. R. Stackpole	(a) 4.98	1,230
June 17	R. H. Suttie	4.20	734
Aug. 1	B. L. Bigwood	2.84	139
Nov. 22	H. S. Price	4.57	1,050
1920			
Jan. 13	H. S. Price	(a) 4.01	268
Feb. 18	H. S. Price	(a) 4.15	227
Sept. 14	M. R. Stackpole	3.96	584

(a) Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of White River at West Hartford, Vt., for the two-year period ending Sept. 30, 1920.

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1918-19												
1	1,040	2,840	1,460	1,200	560	960	2,840	1,370	1,280	395	126	215
2	855	1,970	890	2,320	820	2,800	2,320	2,200	1,120	345	140	247
3	925	1,550	1,370	1,860	580	1,550	2,200	1,970	1,040	305	126	215
4	1,200	1,370	1,280	1,650	600	1,200	2,320	1,650	960	265	110	175
5	960	1,550	1,200	890	600	1,950	2,440	1,750	820	230	132	230
6	2,570	1,460	890	960	600	3,100	2,700	1,750	750	230	155	175
7	2,840	1,370	890	1,040	540	1,500	4,000	1,550	820	247	187	146
8	1,650	1,200	960	1,370	520	1,450	4,540	1,750	890	265	172	114
9	1,370	1,200	1,200	1,370	480	1,370	3,640	1,460	820	230	162	820
10	1,120	1,120	960	1,040	440	2,440	3,300	1,370	1,370	200	175	717
11	1,040	1,120	652	980	330	1,860	3,300	1,370	925	200	140	472
12	890	960	855	740	270	1,460	8,950	1,460	717	265	152	890
13	820	925	1,040	770	320	1,750	4,540	1,280	620	230	126	4,000
14	960	890	1,040	960	420	1,200	3,640	1,120	590	215	138	1,370
15	785	890	1,550	1,150	400	1,200	2,840	1,040	620	200	132	890
16	717	820	2,200	920	400	1,200	2,570	960	620	187	146	717
17	685	820	1,550	920	480	1,040	3,140	1,200	750	187	142	620
18	750	1,370	1,200	880	340	1,200	3,470	3,820	750	200	106	500
19	785	7,100	925	800	310	1,970	2,990	3,640	560	187	150	420
20	717	4,000	925	780	290	1,970	2,440	1,750	620	170	160	370
21	1,200	2,700	1,040	720	340	3,640	2,320	1,460	685	155	175	325
22	1,120	2,080	1,040	700	310	4,000	2,200	4,540	500	187	162	325
23	890	1,750	4,360	680	330	2,440	1,970	7,500	445	265	146	472
24	820	1,650	2,840	1,700	420	2,440	1,860	5,300	395	247	160	530
25	750	1,460	3,470	1,500	370	2,320	1,970	3,300	370	200	134	685
26	750	1,370	2,840	980	420	2,320	1,650	2,700	345	175	175	652
27	1,040	1,280	2,080	1,000	370	2,700	1,550	2,570	472	160	155	560
28	925	1,200	1,650	820	340	16100	1,460	2,200	1,040	150	165	420
29	820	1,750	1,370	720	.....	8,320	1,650	1,860	560	170	155	420
30	960	1,860	1,200	700	.....	4,730	1,550	1,650	472	160	155	370
31	5,110	.....	1,040	720	.....	3,640	.....	1,370	.....	155	187	.....
1919-20												
1	305	2,080	2,700	340	130	200	4,180	4,000	750	620	265	155
2	285	2,200	1,970	300	175	175	5,300	3,300	590	500	265	175
3	560	1,750	1,370	300	180	200	5,300	2,990	560	925	230	170
4	590	1,370	1,200	270	150	200	4,730	2,990	530	1,370	200	155
5	500	1,550	1,280	250	150	200	4,540	2,570	560	1,200	200	155
6	685	1,550	1,370	270	200	260	4,180	2,440	960	960	175	110
7	1,460	1,460	1,200	270	175	620	4,730	2,570	1,040	717	170	138
8	890	1,370	1,370	270	200	620	2,990	2,700	855	685	138	175
9	717	1,280	1,280	270	210	500	2,440	2,990	750	750	148	187
10	750	1,280	2,700	280	210	400	2,320	2,440	652	652	173	175
11	785	1,200	1,550	270	175	350	2,440	1,970	530	500	173	230
12	685	1,750	1,550	270	250	400	2,840	1,970	530	472	420	230
13	620	4,180	1,750	300	210	2,100	8,740	1,750	652	652	395	560
14	560	2,840	2,840	220	210	4,700	10400	1,550	445	590	370	590
15	530	2,080	1,860	200	200	2,300	6,700	1,750	370	590	345	395
16	590	1,550	1,280	175	200	1,550	8,320	1,460	530	560	500	230
17	1,370	1,460	1,120	200	160	3,000	6,700	1,370	560	445	370	300
18	1,040	1,370	890	200	250	3,600	5,500	1,280	620	370	230	230
19	820	1,280	820	160	280	1,950	4,730	1,200	890	345	215	230
20	750	1,200	785	175	260	1,550	4,730	1,120	685	785	200	187
21	685	960	750	185	250	1,300	4,920	1,280	717	620	175	170
22	1,120	1,200	717	150	250	1,200	11500	2,990	960	395	230	150
23	1,120	1,750	685	175	260	1,350	9,160	1,970	750	370	134	160
24	925	1,550	685	200	260	5,300	9,160	1,550	590	345	175	175
25	820	1,280	620	175	260	10000	5,900	1,460	472	305	165	155
26	750	1,280	560	160	250	9,600	4,360	1,280	345	325	162	130
27	1,120	1,460	590	175	230	7,900	3,640	1,120	370	285	150	136
28	1,200	1,280	560	200	200	7,300	5,900	960	305	230	128	146
29	1,650	1,120	470	140	200	6,700	6,100	890	395	215	134	155
30	1,200	3,300	370	185	.....	6,100	4,920	750	500	230	126	230
31	1,370	.....	370	140	.....	5,110	.....	750	.....	215	160	.....

Monthly discharge of White River at West Hartford, Vt., for the two-year period ending September 30, 1920.

(Drainage area, 687 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
1918-19					
October	5,110	685	1,200	1.75	2.02
November	7,100	820	1,720	2.50	2.79
December	4,360	652	1,480	2.15	2.48
January	2,320	680	1,060	1.54	1.78
February	820	270	436	.635	.66
March	16,100	960	2,770	4.03	4.65
April	8,950	1,460	2,880	4.19	4.68
May	5,300	960	2,220	3.23	3.72
June	1,370	345	731	1.06	1.18
July	395	150	218	.317	.37
August	187	106	150	.218	.25
September	4,000	114	602	.876	.98
The year	16,100	106	1,290	1.88	25.56
1919-20					
October	1,650	285	854	1.24	1.43
November	4,180	960	1,670	2.43	2.71
December	2,840	370	1,200	1.75	2.02
January	340	140	222	.333	.38
February	280	130	212	.309	.33
March	10,000	175	2,800	4.08	4.72
April	11,500	2,320	5,580	8.12	9.06
May	4,000	750	1,920	2.79	3.22
June	1,040	305	615	.895	1.00
July	1,370	215	556	.809	.93
August	500	126	223	.325	.37
September	590	110	203	.295	.33
The year	11,500	110	1,340	1.95	26.50

Per cent of time duration of White River at West Hartford, Vt., for the 5-year period Oct. 1, 1915, to Sept. 30, 1920.

(Drainage area, 687 square miles).

Sec-ft. per sq. mi.	Sec.-ft.	1915-16	1916-17	1917-18	1918-19	1919-20	Aver-age	Max-imum	Min-imum
0.05	34	....	....	100.0	....	....	100.0	100.0	100.0
.1	69	100.0	100.0	99.1	....	....	99.8	100.0	99.1
.15	103	99.5	99.4	99.1	100.0	100.0	99.6	100.0	99.1
.2	137	97.8	98.9	97.5	97.5	97.8	97.9	98.9	97.5
.3	206	89.4	87.4	82.5	85.7	79.2	84.8	89.4	79.2
.4	275	81.7	80.5	74.0	81.4	68.3	77.2	81.7	68.3
.5	344	69.2	62.0	64.5	78.0	65.0	67.7	78.0	62.0
.6	412	64.8	55.9	54.3	75.0	59.8	62.0	75.0	54.3
.7	481	62.9	46.5	46.3	71.2	58.2	57.0	71.2	46.3
.8	550	57.1	42.7	43.3	69.9	55.2	53.6	69.9	42.7
.9	618	53.8	40.2	40.3	67.5	50.5	50.5	67.5	40.2
1.0	687	49.2	38.4	34.8	64.5	45.6	46.5	64.5	34.8
1.1	756	44.2	36.7	32.6	59.7	41.8	42.4	59.7	32.6
1.2	824	41.3	35.1	29.6	55.4	40.2	40.3	55.4	29.6
1.3	893	39.1	33.4	26.6	51.5	38.8	37.9	51.5	26.6
1.4	962	35.6	31.2	25.2	46.3	36.9	35.0	46.3	25.2
1.5	1,030	32.5	31.2	25.2	45.5	36.9	34.3	45.5	25.2
1.6	1,100	32.5	29.9	23.3	41.6	36.3	32.7	41.6	23.3
1.75	1,200	27.9	28.2	21.6	39.7	34.4	30.4	39.7	21.6
1.9	1,300	26.0	26.3	19.2	34.2	28.4	26.8	34.2	19.2
2.05	1,410	24.0	24.4	18.1	29.9	25.1	24.3	29.9	18.1
2.25	1,550	21.0	23.0	17.5	26.8	23.5	22.4	26.8	17.5
2.5	1,720	19.4	20.6	15.6	22.2	20.5	19.7	22.2	15.6
2.75	1,890	16.9	17.5	14.5	18.9	18.6	17.3	18.9	14.5
3.0	2,060	15.0	16.2	14.5	17.0	17.2	16.0	17.2	14.5
3.5	2,400	12.8	12.3	11.8	13.4	15.6	13.2	15.6	11.8
4.0	2,750	10.4	9.0	10.4	10.1	13.1	10.6	13.1	9.0
4.5	3,090	7.9	6.8	8.2	7.9	10.7	8.3	10.7	6.8
5.0	3,440	4.9	5.5	6.6	6.6	10.1	6.7	10.1	5.5
7.0	4,810	1.9	2.7	2.5	1.9	6.6	3.1	6.6	1.9
10.0	6,870	.5	1.4	.5	1.4	2.7	1.3	2.7	.5
15.0	10,300	.0	.0	.0	.3	.5	.16	.5	.0
20.0	13,700	....	....	....	.3	.0	.06	.3	....
25.0	17,200	....	....	....	.0	....	.00	.0	....
30.0	20,600	....	....	....	....	....	....	....	....

West River at Newfane, Vt.

Location.—At covered highway bridge 1¼ miles northeast of village of Newfane, Windham County.

Drainage area.—310 square miles.

Records available.—September 13, 1919, to September 30, 1920.

Gage.—Chain on downstream side of highway bridge.

Discharge measurements.—Made from highway bridge or by wading.

Channel and control.—Gravel and ledge; well defined ripple just above island 800 feet below gage; probably permanent.

Extremes of discharge.—1919-1920. Maximum stage recorded, 11.75 feet at 6:10 p. m. April 13, 1920 (discharge not determined); minimum stage recorded, 3.69 feet on morning and afternoon of September 27, 1920 (discharge, 53 second-feet).

Ice.—River freezes over and stage-discharge relation seriously affected.

Regulation.—A few small mills above the station do not seriously affect the distribution of flow.

Accuracy.—Stage-discharge apparently permanent except when affected by ice. Rating curve fairly well defined between 70 and 2,000 second-feet. Gage read to half-tenths twice daily except from December 24 to March 25, when it was read once a day. Daily discharge ascertained by applying rating table to mean daily gage heights, with corrections for effect of ice during the winter. Results good.

Discharge measurements of West River at Newfane, Vt., during period September 13, 1919, to September 30, 1920.

DATE	MADE BY	Gage Height	Discharge
1919		Feet	Sec.-ft.
Sept. 13	M. R. Stackpole	5.66	1,360
14	B. L. Bigwood	4.85	651
1920			
Jan. 12	H. S. Price	(a) 4.91	250
Apr. 7	H. S. Price	6.10	1,790
Aug. 24	J. L. Lamson	3.81	77

(a) Stage-discharge relation affected by ice.

Note—Additional discharge measurements made subsequent to Sept. 30, 1920, were used in developing the rating curve.

Daily discharge, in second-feet, of West River at Newfane, Vt., for the period Sept. 13, 1919.

DAY	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1919												
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												1,580
14												618
15												320
16												281
17												220
18												170
19												150
20												142
21												124
22												118
23												441
24												372
25												309
26												250
27												215
28												179
29												130
30												121
31												
1920												
1	109	1,890	1,580	240	115	65	2,560	1,530	166	124	97	115
2	109	1,680	968	250	130	65	3,130	1,310	174	124	134	95
3	162	1,310	678	220	115	65	2,920	1,190	166	124	103	87
4	174	907	620	260	150	65	2,400	1,310	142	130	85	80
5	154	1,310	660	260	150	75	2,770	1,130	174	115	73	69
6	146	1,260	700	240	130	170	3,030	933	1,030	106	69	57
7	420	933	740	320	130	350	1,890	882	602	115	69	73
8	255	831	660	220	130	660	1,350	1,010	427	100	69	73
9	197	754	780	260	130	700	1,080	1,580	326	95	63	73
10	309	652	1,630	260	115	660	995	1,190	245	100	63	92
11	413	627	1,040	290	100	490	1,080	968	174	95	303	303
12	309	986	865	260	100	450	1,140	797	174	100	392	166
13	225	1,790	865	260	100	1,050	4,580	754	166	130	298	220
14	197	1,490	1,890	240	115	3,600	3,750	729	134	138	635	250
15	179	907	1,170	220	150	2,800	2,300	695	142	134	594	158
16	188	678	848	190	130	2,500	3,030	586	162	166	298	103
17	1,030	578	680	190	100	2,500	2,720	546	240	121	215	112
18	546	538	460	190	100	2,900	2,240	538	1,400	103	183	85
19	372	515	380	170	100	2,400	2,140	522	968	146	142	85
20	320	492	380	170	100	2,000	2,240	554	515	538	109	77
21	265	515	370	150	85	1,600	2,460	977	470	220	100	77
22	515	485	370	150	100	1,300	3,540	1,350	627	121	90	69
23	586	578	330	150	100	1,300	3,130	890	420	121	82	63
24	359	530	420	150	100	2,100	3,540	720	265	166	80	69
25	298	427	320	130	85	3,000	2,190	618	206	174	75	63
26	265	882	290	115	85	3,440	1,680	538	179	121	75	63
27	610	1,680	320	115	75	4,160	1,530	427	150	97	71	53
28	712	1,080	350	115	65	3,650	3,340	339	138	97	75	67
29	916	763	290	100	65	2,920	2,820	270	130	92	65	61
30	570	2,400	260	115	.....	2,920	1,990	183	138	92	59	118
31	1,020	.....	260	115	.....	2,820	.....	174	.....	92	75	....

Monthly discharge of West River at Newfane, Vt., for the year ending September 30, 1920.

(Drainage area, 310 square miles)

MONTH	DISCHARGE IN SECOND-FEET				RUN-OFF
	Maximum	Minimum	Mean	Per square mile	Depth in inches on drainage area
October	1,030	109	385	1.24	1.43
November	2,400	427	982	3.17	3.54
December	1,890	260	683	2.20	2.54
January	320	100	197	.636	.73
February	150	65	109	.352	.38
March	4,160	65	1,700	5.48	6.32
April	4,580	995	2,450	7.90	8.81
May	1,580	174	814	2.62	3.02
June	1,400	130	342	1.10	1.23
July	538	92	135	.435	.50
August	635	59	156	.503	.58
September	303	53	103	.332	.37
The year	4,580	53	672	2.17	29.45

WHITE RIVER BASIN

General Features

White River, the largest Vermont tributary of the Connecticut, drains an area of 710 square miles, the greater part of which is in Windsor and Orange counties. Small areas in the southern part of Washington county and the eastern part of Addison county are also drained by tributaries of White River.

The Rochester sheet, U. S. Geological Survey topographic map, shows the river as rising north of Battell Mountain in the town of Ripton at an elevation of about 3,700 feet. It flows in a general easterly direction about 4½ miles to the village of Granville, where it is joined by Alder Meadow Brook and Kendall Brook; it then turns sharply to the south and flows through the central part of Granville to the village of Hancock, a distance of 4 miles, where it is joined by Robins Branch from the west. From Hancock to Rochester, 4 miles farther, the river course is somewhat winding, but generally east of south. West Branch which rises in the southwestern part of Hancock and drains the western part of Rochester, joins the main river about a mile south of Rochester village. After the confluence with West Branch the course of the river is slightly south of southeast for a distance of 6 miles to the village of Stockbridge. Half a mile south of Stockbridge, another West Branch, sometimes called Tweed River, or Pittsfield Branch, enters from the west. This branch drains a mountainous area in Chittenden and Pittsfield called "Michigan," practically all of which is covered with forest. Between Pittsfield and the mouth of Tweed River, the valley broadens out into a basin of fertile farm lands.

About a mile below the mouth of Tweed River, there enters a tributary from the south called Stony Brook. In this vicinity White River begins a wide swing to the northward, and from Gaysville to Bethel its course is very nearly northeast. The White River Valley R. R., a steam railway of standard gage, although little used, connects the towns of Rochester and Bethel, and follows close to the river throughout most of the distance of 18 miles. At Bethel the river is joined by a branch known as the Third Branch or Randolph Branch. This branch rises in Roxbury and follows a general southerly and southeasterly direction, passing through parts of the towns of Granville, Braintree and Randolph. It is closely followed throughout its course by the main line of the Central Vermont R. R., which is also located close to the river from Bethel to White River Junction.

From Bethel to Sharon, a distance of about 12 miles, the river has a general easterly direction, making a northward swing

just below the village of Royalton, but swinging still more to the south at South Royalton. At North Royalton the river is joined by the Second Branch, and at South Royalton by the First Branch; both of these tributaries entering from the north after following nearby parallel courses through the western part of Orange County.

After making a swing farther to the south at Sharon, the river flows in a southeasterly direction to its confluence with the Connecticut River at White River Junction in the town of Hartford.

Throughout most of its course the river flows over a bed of gravel and alluvial deposits, much of it being water worn fragments of glacial debris. Wide flood plains and terraces border the river, and form fertile meadows between the side walls of the valley. The side slopes are generally steep and rise a thousand feet or more in the distance of a mile back from the river. The tributary streams are likewise bordered by abrupt side walls, and all have rather steep grades. These steep side slopes give the river a quick run-off, and cause a rapid rise in stage whenever the rainfall is at all heavy. There are very few lakes and ponds in the basin, and the few small ones which exist have tributary drainage areas so small that they are of no value in regulating the flow of the river.

Records of the flow have been obtained at the following gaging stations:

White River at Sharon, 1903-1904 and 1909-1912.

White River at West Hartford, 1915-1920.

A gage was established on the Second Branch of White River near North Randolph, October 15, 1920.

On page 50 of this report, there is given a duration table which shows the percent of time for which different rates of flow have been maintained during each year of the 5-year period, 1915-1920. This table will be found useful in connection with studies of power developments on the river.

Water Powers

There are seven dams now in existence on White River, although not all of them are in use at the present time. The three principal tributaries, the first, second, and third branches, have numerous small power developments, and a number of dams also exist on the smaller tributaries.

The first dam above the mouth of the river is that of the Hartford Woolen Company at Hartford. This is a timber structure about 450 feet long and 8 feet high, giving a head of 11 feet on the water wheels. This dam is now in poor condition and

unless rebuilt or extensively repaired will probably not withstand many more flood stages. Some additional head could probably be obtained at this place. There are two water wheels rated at 60 horsepower each, and steam engines of 200 horsepower capacity are used for auxiliary power. It can easily be seen that the water power might be materially increased here. With the present head of 11 feet, and new water wheels of the proper size to use the water efficiently, the flow of the river should give during 90 per cent of the time a power output 50 per cent greater than the rated capacity of the old water wheels, and during 9 months of the year, or 75 per cent of the time, the power would be nearly three times that now obtained from the present wheel installation. The pond back of the dam is comparatively small, and only the natural flow of the river is to be had.

The second dam on the river is that of the Sharon Power Co. (Vermont Copper Co., lessee), about a mile below the village of Sharon. This is a concrete dam built in 1908, and at ordinary stages gives a head of 18 feet, which may be increased to 20 feet by the use of flashboards. At high water the head is at times reduced to as low as 10 feet, on account of filling up the river channel below the dam. The power house located on the right bank of the river is provided with two units, each unit consisting of a 400 horsepower water wheel direct-connected to a 250-kilowatt generator. The dam and power houses were built to provide electric power for the mines of the Vermont Copper Co., at South Strafford. (See 1917-1918 Report of State Geologist of Vermont, page 141.) A 200 horsepower gasoline engine at So. Strafford is available for auxiliary power. Mining operations have been unsuccessful, and as no other market has been provided for the power, the water has run to waste over the dam most of the time during the past five years. The construction of the concrete dam in 1908 flooded out a timber dam which had been built in the village of Sharon, and forms a pond about three miles long.

The third dam across White River is in the town of Bethel, about three-fourth of a mile below the mouth of the Third Branch. This is a timber crib dam 260 feet in length which was built about 25 years ago and gives a head of 18 feet. The power house was completely remodeled in 1917, and is provided with electric generators of 550 kilowatts capacity. The power is used in the stone sheds and tannery at Bethel, and for lighting; the plant being connected with other developments of the Hortonia Power Co., allows for an interchange of power according to the demands in the territory served by this company. A steam turbine at the stone sheds provides for auxiliary power when

needed there. It is stated that water wastes over the dam about 6 months of the year.

The next dam on the river is in the village of Gaysville, town of Stockbridge, and is also one of the Hortonia Power Co. properties. This is a timber dam 117 feet long, and it gives a head of 25 feet on three water wheels. The wheels, which were installed in 1908, have a combined capacity of 500 horsepower, the power being taken into the Hortonia system for general lighting and power purposes. The operator states that water wastes over the dam about 6 months in the year.

The fifth dam is an old timber dam in the village of Rochester owned by the Eastern Talc Co. About 8 feet of head was at one time obtained here, but no use is now made of the power.

A little farther upstream in the village of Rochester is the dam owned by Goodnow and Hubbard. This is a log dam 300 feet long and it gives a head of about 8 feet, which has been used for running a grist mill and a saw mill. A 35 horse power water wheel, installed in 1902, is now idle, and power when needed is obtained from a 45 horsepower gasoline engine.

The seventh dam is that of the Granville Manufacturing Co. at Granville, where 160 horsepower is used in the manufacturing of lumber and wooden ware. This is a new log dam, built in 1920, and gives a head of 28 feet. A 15 horsepower gasoline engine is used for auxiliary power when the water is low.

First Branch of White River

The First Branch, so called, joins White River near the village of South Royalton. About a mile above the mouth there are two dams; at the first dam a head of 14 feet is obtained and was used for many years for running a grist mill and a saw mill. The grist mill is now closed for lack of custom, but the saw mill continues to do a good business. A total of 70 horsepower is developed at this dam. The mill pond is small, and operation is dependent upon water passing the dam immediately above. The second dam gives a head of 8 feet, and sets the water back for a distance of a mile. There is but one water wheel, and that has a rating of 27 horsepower. The power has been used for various purposes, principally woodworking, but at one time a shoe manufacturing plant was in operation. No use is now being made of the power at this dam.

The next dam, about a mile below the village of Tunbridge, develops a head of 11 feet which is sometimes increased by the use of flashboards. One water wheel of 50 horsepower capacity is used for operating a saw mill. The pond extends back about a mile.

The fourth dam is at Tunbridge village, and develops a head of 16 feet. The power is used for a saw mill and a grist mill, the two wheels giving about 95 horsepower, but only the grist mill can run during low water. A short distance upstream, there is another dam with a head of 12 feet use for operating a woodworking shop. About 50 horsepower is developed.

The sixth dam is at North Tunbridge, where a head of 10 feet is obtained. Three water wheels are installed, with a combined capacity of 65 horsepower, but they can be used to full capacity only during the spring and fall. During low water only the grist mill or small band saw are used.

The next development is in the town of Chelsea, about 3½ miles below Chelsea village. This is a saw mill operated by a 43 horsepower water wheel under a head of 10 feet. During July and August the mill can ordinarily run only half a day at a time.

One mile below Chelsea village a head of 16 feet is used for operating a saw mill and a grist mill. The two water wheels have a combined capacity of 95 horsepower, but they can both be used at full gate only when the water is high.

In Chelsea village there are two dams. The first dam is used for a grist mill with three water wheels which develop 40 horsepower under a head of 12 feet, but at low water only one wheel can be used. The upper dam gives 18 feet of head which is used by a saw mill. The wheel is rated at 40 horsepower, but can be used only half a day at a time during the summer.

The total developed head on the First Branch amounts to 127 feet, with a water wheel installation of 575 horsepower. It will be noted that not all of this power is now being used, some of the wheels being idle, but that now in use is for local purposes, principally for saw mills and gristmills. No electrical development has yet been made; the power for electric lights in towns along the First Branch comes from developments on the Second Branch.

Second Branch of White River

The first dam on the Second Branch is about two miles above the mouth and was formerly known as Stoughton's Mills. For many years this power was used for a grist mill, but with the decline of the milling industry and the demand for electric power for lighting purposes, the plant was remodeled and a 60-kilowatt generator installed by the Royalton Power Company. The present water wheel, installed in 1909, has a rating of 90 horsepower and is supplemented by a 125 horsepower steam engine. The head under maximum allowable water level is 18

feet 3 inches. This head might be increased 15 feet by building a dam a little farther upstream, and a considerable amount of storage obtained. The higher water level would flood several acres of farm land and require the relocation of a few hundred feet of highway. The power is used for lighting the village of Royalton, South Royalton, Tunbridge and Chelsea.

At East Bethel an old log dam develops a head of 14 feet. Four water wheels with a combined capacity of 120 horse power are used for running a saw and shingle mill, grist mill and creamery. The wheels can all be used only during periods of high water, a 10 horsepower steam engine being used for the creamery when water is low.

The third dam is at the village of East Randolph. This is a concrete structure built in 1915 and develops a head of 10 feet. One 25 horsepower water wheel is directly connected to an automatically controlled electric generator which delivers current at 110 volts for use in East Randolph village. Service is furnished 24 hours a day during the winter; during the summer service is limited to 14 hours a day, except that continuous service is given on 2 days a week to allow for the use of numerous small motors and household electrical equipment. The operation of the plant is said to be very satisfactory and is financially successful. Previous to the installation of the hydro-electric station the water power was used for running a grist mill, saw mill, and creamery.

About a mile below North Randolph village, a head of 14 feet has been developed. The old timber dam is in poor condition and leaks so badly that the water power is of little use. The capacity of the water wheels is 70 horsepower, but a 20 horsepower steam engine is depended upon to operate the creamery, which is the sole user of power at the present time. With a new dam 8 feet higher than the old one, a head of 22 feet would be obtained, and the higher water level would create a pond covering about 75 acres. The first dam at this site was built in 1799.

At North Randolph village a head of about 9 feet is obtained and a 40 horsepower water wheel is used for operating a saw mill, shingle mill, and grist mill. During a large part of the time there is insufficient water for operating purposes.

Pond Brook coming in from the west joins the Second Branch at East Brookfield village. This stream has a large amount of fall, and in years past there have been developments which utilized betwen 90 and 100 feet of head and probably gave more than 150 horsepower. Of these old developments, all are now abandoned except two, a cider mill and a saw mill. These dams have heads of 12 feet and 20 feet respectively, with wheel installations amounting to 55 horsepower. A 12 horse-

power gasoline engine is also used for auxiliary power at the cider mill. There are several ponds above the upper dam, the largest of which is Brookfield Pond, about 50 acres in size. Brookfield Pond and two small ponds above that have been dammed and the flow controlled by gates. Another pond of about 10 acres might also be used for storage.

Apparently, there are possibilities for developing 300 feet of head in addition to that now in use. The tributary drainage area is comparatively small, but the flow might be well regulated by storage in the ponds and lakes.

Third Branch of White River

The first dam on the Third Branch is in Bethel village, not far above the confluence with White River. The dam is of timber crib construction and about 5½ feet high, with 2½ feet of flashboards, giving a maximum head of 30 feet. One water wheel of 75 horsepower is used for a saw mill, and one wheel of 50 horsepower for a grist mill. The grist mill is run throughout the year, but there is insufficient water for both wheels during low water periods.

The next dam is at Randolph village, where a head of 10 feet develops 25 horsepower for use in a foundry. The pond back of the dam is small, and operation is dependent upon water as it passed the dam just above. A 25 horsepower, electric motor is used for auxiliary power.

The upper dam in Randolph village is an old log structure which leaks badly. At this dam a 45 horsepower wheel under a head of 14 feet is used for a grist mill, and a 40 horsepower wheel with a head of 12 feet for a saw mill. There is a shortage of water during three months of the year, and auxiliary power from electric motors is used; the motors having a combined capacity of 75 horsepower.

The fourth dam is at Braintree, where a head of 9 feet is obtained. One 40 horsepower water wheel is used for a grist mill; a second wheel of 25 horsepower used for the saw mill was injured by fire in the spring of 1919, and has not yet been replaced. A 100 horsepower steam engine is used for additional power.

Ayers Brook joins the Third Branch near Randolph village. This stream rises in Brookfield and flows through the northeastern corner of Braintree. At East Braintree there is a log dam which gives a head of 13 feet and one water wheel is installed with a capacity of about 50 horsepower. Only about 30 horsepower can be obtained, however, on account of the small size of the approach channel. The power is used for running a saw

and grist mill. The drainage area above this point is small, and but little water is available except during the high water period.

Tweed River

This stream, which joins White River at Stockbridge, has two developments. The first is a new concrete dam about one-fourth mile above the confluence with White River. Three water wheels aggregating 175 horsepower under a head of 12 feet are used for operating wood turning machinery, a saw mill, and a small electric generator. There is not enough water for operating at full capacity during low water periods. An excellent opportunity exists for a storage dam a short distance above this development.

In Pittsfield village a dam furnishes a head of 18 feet for wheels of 80 horsepower capacity. The power is used for a saw mill, and there is said to be sufficient water except during two months in the summer.

Miscellaneous Small Dams

There are undoubtedly a number of small dams on brooks tributary to White River which are not included in the above list. At some of these dams the power is of considerable use locally, but taken all together the aggregate amount of power developed at these few miscellaneous dams is comparatively small.

Storage

As will be seen by examination of the discharge tables, there is need for additional storage if the water power developments are to be operated efficiently. This is true for all Vermont rivers, and especially the White River, where there is a wide variation between the high flow of early spring and the low flow of summer and mid winter. As has been stated, there are very few lakes and ponds in the basin; nor are there many opportunities for building reservoirs. One opportunity on the Second Branch has already been mentioned. Another possibility is on Tweed River, where there is an excellent site for a dam just above Barrow's Mill. A short dam at this place would make a pond three miles long, setting the water back as far as Pittsfield. About two miles of highway would have to be relocated and the meadow lands on several farms would be covered.

There are also possible reservoir sites on the river between Stockbrige and Pittsfield, but on account of damages to the

railroad and highway, and to farm lands and buildings, the cost would probably be prohibitive.

Considering the use now being made of the water power, there is little probability of any storage projects being undertaken in the near future.

Summary of Water-Power Developments in the White River Basin

Name of Stream	Tributary to	Total developed head now used	Total water wheel installation	Auxiliary power	Head once used but now abandoned	Additional possibilities
		Feet	H.P.	H.P.	Feet	Feet
White River	Connecticut at White River Jct.	100	2,350	960	16	35
First Branch	White River at South Royalton	127	575	....	....	20
Second Branch	White River at North Royalton	65	345	155	....	25
Pond Brook	Second Branch at East Brookfield	32	55	12	60	300
Third Branch	White River at Bethel	63	300	200	....	....
Ayers Brook	Third Branch at Randolph	13	30	....	....	....
Tweed River	White River at Stockbridge	30	255	....	....	100
Total		430	3,910	1,327	76	480